THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT No. 47 CEDAR STREET, NEW YORK.

M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART. . . . . Associate Editor.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid	$3 00
Subscription, per annum, Foreign Countries	3 50
Single copies	25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

NEW YORK, JUNE, 1891.

AN article which will be found upon another page gives a concise but full account of some careful tests of a compound locomotive made recently upon the Mexican Central Railroad under the direction of Mr. F. W. Johnstone, Superintendent of Motive Power of that road. The manner in which the experiments were carried out is fully given, and the resulting economy in fuel shown to be very considerable. This is a much more important point on the Mexican Central than in many other lines, since fuel is very scarce on its line, is all brought from a distance, and costs the railroad on an average as high as $11 per ton.

The results of these tests have been so successful that the company has ordered six new engines, of the type designed by Mr. Johnstone, from the Rhode Island Locomotive Works, and further proposes to alter some 50 of its old engines to compound as fast as they can be brought into the shop.

THE preliminary survey has been begun for a water-power canal which is to take water from the Niagara River at Tonawanda, near Buffalo, and to run thence to Lockport, where the projectors expect to utilize the power obtained from the fall. From Lockport it is to run to Olcott, where an additional fall will be obtained before the water is discharged into Lake Ontario. It is expected that some 250,000 H.P. can be obtained. The distance from Tonawanda to Lockport is about 15 miles; from Lockport to Olcott, 12 miles.

AN expedition to the North Pole by way of the interior of Greenland has been planned by Civil Engineer R. E. Peary, U. S. N., who will undertake the trip with a small party provided with dog sledges of the Eskimo pattern. He believes that in this way, carrying a light load and traveling rapidly, he can penetrate further to the northward than any one has yet been able to do.

THE Interstate Commerce Commission gave recently a decision of considerable importance in the matter of complaint made by the New York & Northern Railroad Company against the New York & New England Company. The complaint of the Northern was that the New York & New England had refused to unite with it in making a through line to New York, while at the same time it had made arrangements by which the through business from its line was sent entirely over the Housatonic Railroad by way of Bridgeport or Danbury, in spite of the fact that equal facilities, rates, etc., were offered by the Northern Road. The Commission on the evidence and arguments has decided that the New York & New England Company is clearly in the wrong, and while not actually holding that a railroad company is bound to establish a through line, it does hold that it must give equal facilities to all connecting lines, and that it cannot establish a through line with one and not with another, where both reach the same point.

This decision, it will be seen, has a wide application, and if other complaints of similar character are brought under the law may make a great deal of trouble for some companies.

IRON production for the first time this year shows a slight increase, the figures collected by the *American Manufacturer* giving 231 furnaces in blast with a weekly capacity of 116,600 tons. These figures show no increase in the number of furnaces, but a gain of 3,300 tons in weekly capacity. As compared with May 1, 1890, the decrease is very considerable, the report showing the number of furnaces less by 110 and the weekly capacity diminished by 64,200 tons, a very serious difference. Part of this result has been due to the difficulties in the coke region, which has forced several of the large coke furnaces to shut down, but the greater part is the result of the diminished consumption of iron so far this year. It is believed, however, that the lowest point has been reached, and that from the present time there will be a steady increase.

THE problem of terminal facilities and connections in Boston has given the managers of the lines entering that city a great deal of trouble. The latest proposition made for its settlement is to connect the various lines by tunneling under the Charles River, the Fort Point Channel and so much of the main harbor as lies between the city proper and East Boston, thus avoiding draw-bridges and all obstructions of the streets. The new plan has already caused much discussion and also much opposition, though at first sight it seems to offer the best solution of the question.

TWO of the strongest advocates and believers in the possibility of Aerial Navigation have recently been in conference—Professor Langley, of the Smithsonian Institute, who some time since announced his belief in the theoretical advantages, and Mr. Maxim, who has spent a large amount in experiments in this direction. It is understood that Mr. Maxim proposes to build a new machine on a large scale, following his original plans to some extent, but modifying them to meet Professor Langley's views.

THE only outcome thus far of the new Rapid Transit Commission in New York has been the presentation of a plan for several extensions of the Manhattan Company's elevated lines. These include several short sections intended to reach the North River ferries and to connect the existing lines, and one long line extending from the pres-

ent Sixth Avenue road at Thirty-third Street up the west side of the city.

What action the Commission will take on these plans is not known at the time of writing; but it seems as if it could hardly be favorable. The tendency of the new lines would be to throw more traffic on parts of the existing roads which are already overcrowded, and not to relieve the present trouble at all, except by furnishing additional facilities to some uptown districts at the expense of additional delay and overcrowding for others.

THERE is also talk of third tracks on the existing structures, over which express trains could be run. A third track, however, would not be sufficient for real express travel, and the so-called fast trains could not be much improvement upon the present service. Any elevated system, to be of real use to the city, must show substantial improvements, which the Manhattan's plan does not promise.

THE present elevated railroads were a great improvement on the horse cars; but a system whose maximum speed does not exceed 12 miles an hour, and whose average is nearer 7 or 8 miles, does not give real rapid transit, and that is what the city needs.

Moreover, while the executive management of the elevated roads has been good up to a certain point, and accidents have been rare, there is a wide-spread public dislike to the general management, which it has certainly deserved by its apparent disregard of public convenience, and its scarcely concealed contempt for public opinion. Any new grants to the Manhattan Company will be regarded with suspicion and resisted in every possible way.

A TEST was made of the range and accuracy of the dynamite guns of the *Vesuvius* in Hampton Roads, May 19. The ship was started at an early hour in the morning, and after firing a number of test shots in order to find the ranges, a final test was made by firing nine dummy or unloaded shells, six from one of the guns and three from another, the range varying from one-half mile to a mile, while some of the shots were fired with the ship nearly at rest, and others when it was running at full speed. The accuracy was fairly good, most of the shots striking within 20 or 30 yards of the mark, the average being about 20 yards, while several struck the target directly. It was estimated by the experts present that, had they been fired at a large vessel, nearly every one of them would have struck some part of the ship or so near as to do it serious injury. It is understood that, as far as the range and the handling of the ship was concerned, the tests were fairly satisfactory. Further tests were made on the following day, with very similar results.

It is very noticeable, however, that in all the tests made of the *Vesuvius* so far only dummy shells have been used. Why cannot a fair trial be made with loaded shells and with some more satisfactory target than a buoy? Then a fair estimate could be formed of the offensive powers of the new cruiser.

THE fight between the *Charleston* and the *Esmeralda*—should one take place—will be an interesting test of strength and skill, and may serve to controvert or establish some theories of naval construction. Meantime the *Charleston* has made a very good showing for speed at sea.

AMERICAN LOCOMOTIVES.

THE *Engineer* of April 24 contains another article on this subject, in which the editor seems to have a confused idea that the Strong locomotive represents American practice, and that Mr. Le Van is a representative American engineer. Now the Strong locomotive is a very ingeniously constructed machine, and it may be better or it may not be as good as the locomotives in ordinary use in this country, but it no more represents the practice here than the Fairly locomotives on the Festiniog Railroad of Wales—with which *The Engineer* at one time was so much infatuated—represents British practice. Perhaps if our contemporary should read a reference to Mr. Le Van in our issue of last month he would not be quoted seriously hereafter.

Is it, we ask, ingenuous in our contemporary to speak of the Strong locomotive as an "intensely American product," and say that it "has always been talked of as superior to any other in existence," and to pretend that it is a representative of American practice? The Strong locomotive is an experiment, and much ingenuity was shown in its design; but in its present stage of development there is not a locomotive superintendent in the country who would recommend its adoption for general use; and it is safe to say that the editor of *The Engineer* knows of its experimental character.

He is silent, however, about the maximum combustion of coal in English and American locomotives, to which reference was again made in our May number. Surely the capacity of locomotives to burn large quantities of coal, when it is of a poor quality, is important in countries where coal is not good.

TRAFFIC AND SHIPPING ON THE GREAT LAKES.

THAT the traffic on the Great Lakes is very large, every one knows in a general way, but its great importance is not fully appreciated until we meet with some definite figures, such as are contained in one of the latest bulletins issued by the Census Bureau. According to this report the cargo tonnage on the lakes for the season of 1889 was 27,460,200 tons, and as the average voyage was 566 miles, the total ton-mileage was approximately 15,578,360,000 ton-miles. This was equal to nearly 23 per cent. of the total ton-mileage reported by all the railroads of the United States last year.

It is interesting to know the sources of this traffic. From the report it appears that 54.2 per cent. of the tonnage consisted of products of mines and quarries—chiefly iron ore and coal; 23.8 per cent. was lumber; 16.5 per cent. products of agriculture, and only 5.5 per cent. general freight. Three articles—coal, iron ore and lumber—furnish 75 per cent. of the lake freight. Coal was the largest item—7,677,107 tons, or 28 per cent. of the total tonnage.

It is to be expected that the water route will take the larger share of cheap and bulky articles, on which the freight charges form a large proportion of the cost, and that all, or nearly all, of these classes of freight should take that route. The lake steamers, however, do much more than this; while they take a comparatively small share of the grain and other higher priced freight, they really regulate and control the rates on all of this traffic. As long as the water lines are active competitors for the business, all rates must be made with reference to them, and they are a prin-

cipal factor, if not the leading factor, in fixing the transportation charges. In this way their importance extends beyond the actual share of the traffic which they obtain.

As showing the proportion of the total freight traffic which originates on or goes to the different lakes, it is of interest to note that the tonnage of freight passed through the Sault Ste. Marie Canal was 8,288,580 tons, while that passing through the Detroit River was 19,717,860 tons. That is, about 30 per cent. of the total lake tonnage was carried from or to Lake Superior ports, while 41½ per cent. went to or from the ports on Lake Michigan and Lake Huron. This, of course, omits all account of commerce between ports on the same lake, which is a considerable item on Lake Michigan, but not very large on Lake Superior. Over 53 per cent. of the Lake Superior traffic is in iron ore, most of which goes through the Detroit River also, and is delivered at the Lake Erie ports. It is to be noted that these reports do not include the trade to or from Canadian ports.

It is interesting to see in what kind of vessels this great traffic is carried. The evolution of the lake carrier has proceeded very rapidly during the past few years. The sailing vessel has given place to the steamer, and the wooden ship to iron and steel. The typical lake steamer is now of steel, arranged to carry the largest possible cargo on a moderate draft; propelled by engines of the latest type, proportioned for the highest speed possible with a moderate coal consumption, and provided with appliances for quick loading and unloading of freight. Great speed is not aimed at; but as the number of trips which can be made in a season is an important element, some study has been given to determining the point at which the increased fuel consumption will overbalance the gain from shorter and more frequent trips.

The Census bulletin on this subject gives figures for five years past; and a comparison between those for 1886 and 1890 will be interesting, as showing the changes in that period:

	1890		1886	
	No.	Tonnage.	No.	Tonnage.
Steamers:				
Side-wheel	42	16,949	43	14,150
Propellers under 1,000 tons	431	154,232	335	177,402
Propellers between 1,000 and 1,500 tons.	122	151,611	72	86,728
Propellers over 1,500 tons	110	188,390	21	34,868
Tugs	448	12,520	466	11,737
Total steamers	1,153	523,702	937	324,885
Sailing Vessels:				
Schooners	577	158,620	730	183,792
Barges	325	144,038	330	125,975
Total, sailing vessels	902	302,658	1,060	309,767
Total, all vessels	2,055	826,360	1,997	634,652

Thus, while the increase in total tonnage has been 30 per cent., that in steam tonnage has been 61 per cent. Moreover, it is hardly fair to call barges sailing vessels, since they depend upon tugs or consort steamers for their motive power. The real sail tonnage—the schooners—has decreased 21 per cent. in number, and 14 per cent. in total tonnage.

The increase in average size of steamers is notable. Disregarding the tugs, which of course are not built to carry cargo, and the side-wheel steamers, which are chiefly in passenger service, or carry only local freight to shore ports, the propellers show an increase of 55 per cent. in number, and of 65 per cent. in tonnage; that is, the average tonnage has increased from 698 to 745, a gain of 7 per cent. The great increase has been in steamers of over 1,000 tons. Even so recently as five years ago, steamers over 1,500 tons were so rare as to be notable; now they are too common to excite remark. The increase in size as well as number is great; the average tonnage of propellers over 1,000 tons in 1890 was 1,468 tons against 1,307 tons in 1886.

The change in ship-building material is considerable also, and can best be shown by a brief table, which includes all vessels, steam and sail:

Material.	1890 No.	1890 Tonnage.	1886 No.	1886 Tonnage.
Steel	68	99,457	6	6,459
Iron	39	24,673	35	22,714
Composite	13	13,554	2	63
Wood	1,935	688,676	1,954	605,416
Total	2,055	826,360	1,997	634,652

Wood will, of course, continue in use for many of the smaller vessels; but steel is the structural material for the large carriers, and that its use will continue to increase there is little doubt.

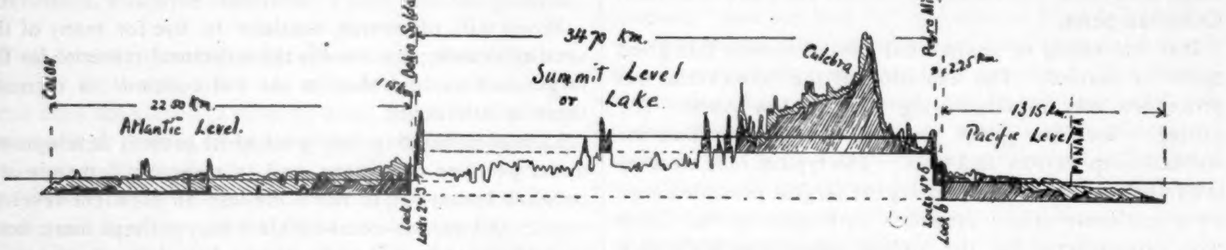
Lake ship-building has reached its present development under peculiar conditions, and to meet the demands of a peculiar trade. It is none the less an excellent development; and our sea-coast builders may perhaps learn some useful lessons from their brethren of the inland waters.

THE PANAMA CANAL.

The French papers have recently published an official report from Lieutenant N. B. Wyse, who has been in Panama as representative of the Official Liquidator, or receiver, of the Panama Canal Company. In his negotiations with the Government he has been fairly successful, having made an agreement extending the canal concession for 10 years, the conditions being made, however, that the new company should be organized and have capital sufficient to begin work in February, 1893, and that the property must be protected in the mean time.

In connection with this report Lieutenant Wyse submits an elaborate plan for the completion of the canal, which is based upon studies made under his directions, by MM. Jacquemin and de Soza, Engineers. This plan provides for the construction or rather the completion of the canal with six locks, and for the formation of an interior lake by the construction of a dam across the valley of the Chagres at Bohio Soldado, and another across the valley of the Rio Grande at Pedro Miguel. The level of this lake would be about 30 m. above the average level of the Atlantic at Colon. Proceeding from the Atlantic end of the Canal the first or maritime level would extend a distance of 22.50 km. to the first lock. This lock would have 10 m. lift, and so give admission to a short level 1.15 km. in length, at the end of which two locks, each of 10 m. lift, would raise ships to the level of the artificial lake at Bohio Soldado. The summit level would extend 34.70 km. to the dam at Pedro Miguel through the artificial lake above mentioned, and at the latter place two locks, each of 10 m. lift, would lower vessels to the second short level, 2.25 km. in length, from which a final lock would lower them to the maritime canal on the Pacific end, which is about 13 km. in length. Possibly a tide lock may be needed in addition at Panama.

The advantages of this plan are carefully set forth in the report. The creation of the central lake would largely reduce the amount of excavation required, and would furnish a long stretch of easy navigation, while at the same time it would serve to equalize and to distribute the flood waters of the Chagres, which have been so serious an obstacle to the completion of the canal on its original plan. Moreover, the dams required would not be of excessive size, nor especially difficult of construction, while by these plans the building of the great dam at Gamboa and the works for the diverting the Chagres would be entirely avoided; and as stated above, the amount of excavation required would be very much reduced. The accompanying sketch gives a profile of the canal as completed on the proposed plan, and also shows the amount of work which will still be required, the heavily shaded



portions showing the excavation still to be done, while the lightly shaded sections show that which has been already excavated.

The great obstacle, in the opinion of the engineers who made the investigation, still remains the excavation at Culebra, but they believe that the time could be shortened and the expense decreased by a system of tunnels and the transportation of the débris by water. As to the supply of water necessary for lockage, there is no question that it will be sufficient.

The estimated cost of the completion of the canal on this plan, as given by the report, is 120,000,000 francs, which, even accepting all the statements made, seems to be a very low one. Even should it be correct, under the present condition of affairs the company will have considerable difficulty in raising this amount. The new securities could only be placed at large discount, and by the admission of the liquidator no interest could be paid during the construction, while the holders of the old securities must postpone all hope of return until 10 years after the completion of the canal. It will also be necessary to raise a considerable amount to take care of and preserve the property on the Isthmus, and the liquidator has no means in hand for that purpose.

Even taking the French view of the case—which is naturally a sanguine one—the prospects of the canal are by no means favorable; and the probability is that the vast sums already spent will be entirely lost. The success which has so far attended the work on the Nicaragua Canal is another discouraging element for the Panama Company.

NEW PUBLICATIONS.

Examinations by the State Board of Health of the Water Supplies and Inland Waters of Massachusetts; *Part I, The Report on Water Supply and Sewerage.* Boston; State Printers.

This report is the outcome of the act to protect the purity of inland waters which was passed by the Massachusetts Legislature in 1886, and amended two years later. Under its provisions the Board of Health undertook a careful examination, not only of the condition of the water supply actually drawn upon by the cities of the Commonwealth, but also of the possible supplies, especially of those which are sure to be soon brought in use in consequence of the rapid growth of city population in the State. The report, after a short introduction, gives a list and brief description of the water supplies of the cities and towns having water works of more or less importance, accompanied by chemical and biological examinations of the present sources of supply and a description of the river basins. The second part includes a chemical examination of the waters, with the methods of analysis and their interpretation, which is the work of Dr. Drown, Chemist of the Board; which is followed by a report upon Organisms found in the waters. A summary of water supply statistics, giving records of rainfall, flow of streams, etc., is supplied by Mr. F. P. Stearns, Chief Engineer of the Board, who also contributes a chapter on the Pollution of Streams by Sewerage and their Purification. The remaining chapters are devoted to a classification of the drinking waters of the State and to some special topics, such as filtration and the effect of storage upon water, especially in large and deep ponds. The report is accompanied by two maps, one showing the location of the different watersheds and the other the comparative amount of chlorine found in the different streams.

Few public documents can be found which are of more value than this, and few works can be undertaken which are of greater importance to the community than the careful examination of water supplies which has been undertaken by the Massachusetts Board, and which we believe has not been carried out, at least with attempt of thoroughness, in any other State, although it deserves imitations everywhere.

Professional Papers of the Corps of Royal Engineers; edited by Captain W. A. Gale, R.E. Chatham, England; published for the Royal Engineers' Institute.

The papers of the Royal Engineers, although many of them are of entirely technical military interest, include some of general value. The present volume is of more general interest perhaps than most of those in the series, since it includes an elaborate paper on Subaqueous Foundations, by Mr. W. R. Kinipple, portions of which have been published in some of the English engineering papers; but it is here given in full with all the drawings and diagrams. Another paper which may be said to have considerable interest to engineers is one by Major R. H. Brown, which describes the methods employed in keeping certain Indian rivers open to navigation during the season of low water. The methods there employed, however, seem to have been in many respects similar to those on our Western rivers; the use of dikes, mattresses, and other devices for directing the current and from preventing shifting in the channel, or upon occasion for partly closing the channel and directing the entire flow of water through one portion of the river-bed, having a strong family likeness to those adopted by our own engineers on the Mississippi and its tributaries.

Among the more technical articles is one on Field Artillery, by General Brackenbury; on the duties of Field Engineers, and on Ships *versus* Forts. The last named is a long and carefully written paper, and many of its conclusions are based upon the experience gained during our own civil war.

BOOKS RECEIVED.

Annual Report of the Board of Regents of the Smithsonian Institution, Showing its Operations and Condition to July, 1889. Washington; Government Printing Office.

Sixth Annual Report of the Board of Mediation and Arbitration of the State of New York: William Purcell, Gilbert Robertson, Jr., Florence F. Donovan, Commissioners. Albany, N. Y.; State Printer.

Postal Savings Banks: An Argument in their Favor by the Postmaster-General. Washington; Government Printing Office.

Practice in Iron Bridge Building: by Professor N. A. Beleloubsky. St. Petersburg, Russia; printed for the Author.

Compressed Air Production: Rules, Tables and Illustrations Relating to the Theory and Practice of Air Compression and Compressed Air Machinery: by William L. Saunders. New York; the *Engineering News* Publishing Company (price 50 cents). This is a reprint of a lecture delivered by Mr. Saunders to the students of Sibley College of Cornell University.

Reports of the Consuls of the United States to the Department of State: No. 126, *March*, 1891. Washington; Government Printing Office.

Annali della Societa degli Ingegneri e degli Architetti Italiani. Anno VI, 1891; *Fascicolo I.* Rome, Italy; published for the Society.

A Technical Description of the Engineering Building of the Massachusetts Institute of Technology: by Professors Chandler, Lanza, Swain, and Woodbridge. Boston; reprinted from the *Proceedings* of the Society of Arts.

Ninth Annual Catalogue of the Rose Polytechnic Institute, with the Course of Study. Terre Haute, Ind.; printed for the Institute.

A Treatise upon the Ordinary Draft Appliances of a Locomotive Boiler as Superseded by More Rational Means: by H. A. Luttgens. Persons interested in this subject can obtain copies of this little book by writing to Mr. Luttgens at Paterson, N. J.

The Q. & C. Company's Illustrated Catalogue of Railroad Specialties, Chicago. This includes illustrated descriptions of car doors of different patterns; tie-plates and locking spikes; the globe ventilator; car replacers or wrecking frogs, and the automatic brake-adjuster.

ABOUT BOOKS AND PERIODICALS.

THE JOURNAL of the Military Service Institution for May has articles on Cavalry in Virginia during the War, by Colonel Crowninshield; Theory of Drift of Rifled Projectiles, by Lieutenant Whistler; Artillery Difficulties in the Next War, by Captain Chester; the Recent Indian Craze, by Captain Dougherty; the New German Rifle and Fire Regulations, by Lieutenant Frost; and a very interesting historical paper on the Red River Dam, by General James H. Wilson.

The steamship article in SCRIBNER'S MAGAZINE for June is on Safety on the Atlantic. Colonel John C. Ropes speaks, in another paper, on the important part played by steam and electricity in the late war. An interesting feature of this number is some remarkable photographs of luminous objects, taken by their own light, and reproduced by mechanical processes directly from the original negatives.

The fifth paper in the series on American Industries in the POPULAR SCIENCE MONTHLY will appear in the June number, and is on the Manufacture of Wool. Another article of interest is on the great progress in sanitation, which has almost doubled the average length of life in civilized countries.

The South American article in HARPER'S MAGAZINE for June is an account of a voyage up the Parana, from Buenos Ayres to Concepcion. This number has the first of a series of articles on London, and the second of Colonel Dodge's papers on American Riders. The other articles include a variety of interesting papers.

In the February number of SCIENTIÆ BACCALAUREUS, published by the Senior Class of the Missouri School of Mines, there are original articles on the Expansion of the Sine and Cosine; on the Prismoidal Formula; on Stadia Measuring and on the Transit of Mercury. There is also a translation of Lobatschewsky's Theory of Parallels.

In the ECLECTIC for May are found articles on Copyright, from the *Contemporary Review*; on Silver, from the *New Review*; on the Seal Islands of Bering's Sea, from *Murray's Magazine*, and a number of general interest, from the best foreign periodicals.

The Wheat Supply of Europe and America is discussed by C. Wood Davis in the ARENA for May. Dr. Blum has an article on Russia, and F. L. King an account of an Interesting Social Experiment. This includes only the papers of special interest; the general reader will find a number of others well worth careful reading.

The latest number of the NATIONAL GEOGRAPHIC MAGAZINE gives the annual reports on the Geography of the Land, by Vice-President Herbert G. Ogden, of the National Geographic Society, and on the Geography of the Air, by Vice-President A. W. Greely.

In recent numbers of HARPER'S WEEKLY there have been given two very interesting series of illustrated articles, one on the buildings for the Columbian Exhibition in Chicago, and the other on Australia. The views of the Exhibition buildings are from the Architect's plans.

The April number of the STEVENS INDICATOR gives a lecture on Drawing-Room Practice, by Professor Coleman Sellers, and a number of articles of special technical interest.

The illustrated article in the OVERLAND MONTHLY for May is a continuation of the paper on Dairying in California. The statistics given on butter and cheese-making will be a surprise to most Eastern readers. In May also is begun a series of historical papers describing, from original documents, some of the intrigues which connected California with the French occupation of Mexico.

In OUTING for May Captain King's appreciative account of the Wisconsin National Guard is concluded. The signs of approaching vacation time are visible in this number, making it at once a tempting and a trying one to the worker, whose own holiday is so short usually that he wants to use it to the best advantage.

Chief among the more serious articles in BELFORD'S MAGAZINE for May is a carefully written paper on the Future of Our Agriculture, by James K. Reeve. Mr. J. L. J. Gage discusses the question, What is Money? in another article. The number is an unusually good one, containing several bright articles of a lighter character.

A new candidate for public favor is the ENGINEERING MAGAZINE, as it is called in the May number; the first number appeared in April under the title of *Engineering*. It has 140 pages about the size of the *Popular Science Monthly*, and contains a number of articles by different authors. The May

contents include Ancient and Modern Water Wheels; Epidemics and Water Pollution; Danger Signals about the Boiler; the Rapid Transit Problem in New York; Building the Steamship in America; Tall Office Buildings; Old-Fogy Methods of Reckoning Time; Electric Railways; Railroad Building in Hawaii, and a condensed summary of engineering news.

Among the new books in preparation by John Wiley & Sons, New York, is one on CAR LUBRICATION, by W. E. Hall, of the Pennsylvania Railroad, which ought to be of interest.

A TWELVE-WHEEL NARROW-GAUGE LOCOMOTIVE.

THE accompanying illustration, which is taken from a photograph, shows a locomotive of 3 ft. gauge, built at the Schenectady Locomotive Works, and recently completed. The engine, it will be seen, is of the twelve-wheel pattern, having eight driving-wheels 37 in. in diameter, and a four-wheel truck, the truck wheels being 22 in. in diameter. The driving-axle journals are 6 × 7 in. in size, and the truck-axle 4 × 6 in. The driving-wheel base is 10 ft. 2 in., and the total wheel base 18 ft., the rigid wheel base being 6 ft. 11 in.

The boiler of this engine is of the wagon-top pattern, and 52 in. in diameter of barrel; it is made of $\frac{7}{16}$-in. steel, the circumferential seams being double riveted and the horizontal seams quadruple riveted with a welt-strip inside. The boiler has 160 tubes of 2 in. outside diameter and 10 ft. 6 in. in length. The fire-box is 84$\frac{1}{8}$ in. in length and 24$\frac{3}{4}$ in. in width; 43$\frac{1}{2}$ in. deep in front and 40$\frac{1}{2}$ in. at the back. The water spaces around the fire-box are 4 in. wide in front and 2$\frac{1}{2}$ in. at the side and back. The crown-sheet is stayed by crown-bars in the usual manner. The grate surface is 14.4 sq. ft. The heating surface is: Fire-box, 90 sq. ft.; tubes, 872.6 sq. ft.; total, 962.6 sq. ft. The inside diameter of the stack is 14 in.

The cylinders are 16 in. in diameter and 20 in. stroke; the steam ports are 14 × 1$\frac{1}{4}$ in., and the exhaust ports 14 × 2$\frac{1}{2}$ in. The Richardson balanced slide valve is used, its greatest travel being 5$\frac{1}{2}$ in. The valves have $\frac{3}{4}$ in. outside lap, $\frac{1}{32}$ in. inside lap, and the lead in full stroke is $\frac{1}{16}$ in. The exhaust nozzles are double and 2$\frac{3}{4}$ in. in diameter.

The engine is expected to use a working pressure of 160 lbs., and will be employed in heavy work on a mountain grade. The total weight in working order is 72,000 lbs., of which 60,000 lbs. are carried on the driving-wheels and 12,000 lbs. on the truck.

The tender is carried on two four-wheel trucks, and weighs 22,800 lbs. empty. The tank has a water capacity of 2,100 galls., and the coal-box will contain 3$\frac{1}{2}$ tons of coal. The truck-wheels are 26 in. in diameter, and the truck axles have 3$\frac{1}{2}$ × 6 in. journals. The truck-wheels are spaced 4 ft. between centers and the total wheel base is 13 ft. 5$\frac{1}{2}$ in. The tender frame is of angle iron; the truck frames are of channel iron with wood bolsters, having center bearings on both trucks with additional side bearings on the back truck. The total wheel-base of engine and tender is 39 ft. 9$\frac{1}{2}$ in. and the total length of engine and tender over all is 47 ft. 8 in.

This is, we believe, the first engine of the twelve-wheel pattern ever constructed for a narrow-gauge road. The twelve-wheel pattern is growing steadily in favor, and the builders state that they have a number of engines of that type at work on mountain roads and heavy grades which are reported as giving better satisfaction in service than the ordinary consolidation pattern.

THE MAPPING OF THE WORLD.

(From *Goldthwaite's Geographical Magazine*.)

THERE are maps without number, but many of them unfortunately are far from perfect. A great many maps are necessarily inaccurate on account of the meagre knowledge we have of large parts of the world. Thus it happens that the best maps we have of many large regions are very poor. The best maps, because the completest and most accurate, are detailed topographical survey maps. They may be called "parent maps," because it is from them that all smaller maps are made where they are accessible. These detailed topographical surveys are the result of exact trigonometrical work, and are carried on at large expense by various governments. Another class of maps which may be called topographical maps are excellent, but are the result of general and not detailed surveys. Then there are detailed geographical maps, which serve a useful purpose where better cannot be obtained. They are compiled from numerous observations and itineraries, and are fairly accurate throughout. Maps of a less degree of accuracy and value are those in which the information is only approximate or hypothetical, and which are sketched from single itineraries and reports. Our mapping of the greater part of Africa is of this nature.

In the *Scottish Geographical Magazine* of June, last year, a very interesting map by Mr. J. G. Bartholomew was published, to show the geographical value of the best maps of all countries. This map is colored so as to show the nature of the surveys or observations, upon which our maps of various countries are based. The first thing we notice on this map is that the largest area of detailed topographical surveys is found in Europe. Almost the whole of Europe has been covered by these exact surveys. Even in the Balkan States, where the easy-going and unscientific Turk has done almost nothing to map the country that was long under his control, the work has been done for him by the enterprise of the Russians, Austrians, and Germans, who naturally have taken a very great interest in mapping this mountainous and debatable quarter of Europe. The first country on the Continent to undertake these minute surveys was France, in 1750, and the work has steadily progressed in various countries, until almost the whole of Europe has been mapped in beautiful and elaborate detail. We find, however, that in a large part of Scandinavia, Spain, and Eastern Russia, map-makers have not yet the advantage of these detailed surveys.

The next largest area of detailed topographical surveys is found in India. It may surprise some of our readers to know that India is one of the best mapped countries in the world. The great cadastral survey of India, in progress for years, was completed only recently. The sheets of this map are on a large scale, and the minute topographical features of the great peninsula are clearly shown.

Our maps of China, of the Himalayas, of Eastern Russia, of Japan, of Cape Colony in South Africa, and of Eastern Australia, are the result of general surveys, and are fairly reliable, though they do not contain the minuteness and variety of information which are results of detailed topographical surveys. The whole of Central Asia has been mapped from many observations and itineraries, and the maps are fairly reliable as far as they go. It is quite certain that our maps of Siberia are far from accurate, for enormous districts in that country have been mapped only from the reports and route surveys of single travelers.

In Africa, we find that general but not detailed surveys have been made in Algeria, along the Mediterranean and Red Sea coasts, in the Nile Valley, as far south as Khartoum, and in Cape Colony and the Boer republics. The larger part of the east and west coasts, though their outlines are without doubt depicted with a fair degree of accuracy, have not yet been adequately surveyed, and are, therefore, not presented on the maps with the greatest accuracy. The mapping of all the rest of Africa has not yet passed beyond the stages of approximately correct or merely hypothetical, and there are large areas in the Sahara, in West Africa behind the Cameroons, in the southern part of the Congo basin, and in East Africa, northeast of Victoria Nyanza, which are not yet so far known, even by native reports, as to give much satisfactory data even for hypothetical mapping.

South America has not yet accomplished anything in the way of detailed topographical surveys, though the enterprise of the Argentine Government has resulted in a general survey of the larger part of her country. It is only

TWELVE-WHEEL NARROW-GAUGE LOCOMOTIVE.

BUILT BY THE SCHENECTADY LOCOMOTIVE WORKS, SCHENECTADY, N. Y.

along the coast line of South America that we find the maps based even upon general topographical surveys, except in Argentina and Uruguay. The larger part of Brazil, Bolivia, and the northern and Pacific Coast republics, are mapped from the observations and travels of numerous explorers. These maps are very inadequate, and the maps which some of the countries print of their territories are anything but satisfactory. Large districts, both north and south of the Amazon River, are still almost unknown, and perhaps will not be represented on our maps with even a fair degree of accuracy for many years to come.

The mapping of our own country is constantly improving, thanks to the great work which is in progress under the auspices of the general government and a number of our States. Every intelligent citizen who appreciates good maps has reason to rejoice over the work the United States Geological Survey is doing. For about 10 years past it has been pushing forward its detailed topographical surveys for the purpose of making a map of the United States. It has been able to use in this work the results of other surveys carried on in various parts of the country, and notably in the Rocky Mountain region, by Government and State organizations. The scale of this map differs in different parts of the country, being about a mile to an inch in the more thickly settled regions, two miles to an inch in less highly developed districts, and four miles to an inch in sparsely settled and desert regions. A characteristic of the sheets of this map is their simplicity and clearness. Only those cultural features which relate to the community, such as cities, roads, railways and so on, are represented. The omission of innumerable items of private culture greatly reduces the number of conventional signs, so that the map is self-explanatory. Upon this map the relief is shown by contour lines or lines of equal elevation above sea-level, thus adding a third dimension to the map. These contour lines are drawn at various intervals of height, depending upon the scale and the character of the country, the one-mile scale being commonly accompanied by a 20 ft. contour interval, the two-mile scale by contour intervals of 20 to 100 ft., and the four-mile scale by contour intervals of 200 or 250 ft. Within the past nine years an area of nearly 500,000 square miles has been surveyed, comprising 555 atlas sheets. This area is widely distributed over the country, embracing parts of nearly every State and Territory, but far the larger part of it is in the western part of the country, between the Missouri River on the north and the Colorado on the south, and including a large part of the Rocky Mountain region. Up to October 30 last, 365 sheets of this map had been engraved.

In the study of maps it is particularly annoying if coast lines are so vaguely laid down that they convey to our minds little definite information. There is no excuse now for poor mapping of our coast line. The operations of the United States Coast and Geodetic Survey have been in progress since 1836, though considerable work in the way of mapping our coast line had been done at intervals before that time. The work of the Survey, at first confined to the Atlantic and Gulf coasts, was extended to the Pacific after the acquisition of California, and has since kept pace with every extension of the territory of the United States. The objects of this work are to accurately delineate the position of the entire coast line upon the earth's surface, to map its topography, and to carry out systematic soundings of the approaches to the coast, its channels, and harbors, to collect information about tides and currents and other data of use to navigators. Since the earliest publication of the charts of the Survey, the accurate representation of all natural coast features has been recognized as essential. The charts are made in the office and are published on various scales, and since 1885 there has been an increase of over 100 per cent. in the number of charts required by the sales agents at the chief seaports. The whole number of charts distributed during the past year was 63,151. While the Coast Survey has charted the southern coast of Alaska, there is a good deal for it yet to do along the northern part of that coast line.

The Dominion of Canada has done little as yet in the way of detailed topographical surveying, though its surveys between the southerly boundary and the sixtieth parallel are sufficiently accurate for most purposes. North of the sixtieth parallel the information yet obtained about this continent is far too meagre to serve as a basis for accurate mapping. It is interesting to observe that a very considerable part of the coast line of West Greenland, from Cape Farewell to Upernavik, has been carefully surveyed, and the wonderful series of fiords penetrating far into the land may, in large part, be accurately delineated on the maps.

LACQUER AS A PROTECTION FOR STEEL SHIPS.

Condensed from paper read before the U. S. Naval Institute by Lieutenant J. B. Murdock, and published in the *Journal* of the Institute.)

THE idea of lacquering iron and steel vessels as a protection against the action of sea-water was suggested to Mr. Hotta, a lacquer manufacturer of Tokio, by the observation that pieces of old lacquer recovered from the sea showed but little action, the lacquer being practically unattacked. As the Japanese were then purchasing iron and steel ships from abroad, and were encountering the same difficulties that were met with elsewhere in protecting the metal, experiments were made on special test-plates, which were immersed in sea-water for considerable periods, generally at the Yokosuka dockyard. The first results obtained were not fully satisfactory, but were very encouraging, and the tests were continued, varying slightly the composition of the lacquer, or adding chemicals to assist in obtaining the desired results. In June, 1886, a practical test was made by lacquering about 1,200 ft. of the bottom of the *Fuso-Kan*, using the preparation of lacquer that at that time had given the best results. The ship was docked again in September, 1887, and the condition of the lacquered portion was so satisfactory that the Admiralty gave an order to lacquer the whole bottom. In December, 1888, the ship was again docked, but the lacquer coat was found to be so good that no repairs were made. In June, 1889, the ship was again docked, the lacquer being still satisfactory. In each case anti-fouling paint was applied over the lacquer. The *Fuso* was docked once more in April, 1890, and although the lacquer covering was almost perfect it was for some unknown reason all removed by scraping, and the bottom was painted.

Many other vessels of the Japanese Navy have since been lacquered. Experimentation has been going on continually. The work is all done by Messrs. Hotta & Company, they holding a monopoly under the laws of Japan, practically the equivalent of an American patent. Not content with merely protecting the metal against corrosion, the contractors have endeavored to meet all the requirements of the case by providing an anti-fouling lacquer preparation, as well as an anti-corrosive. The use of metallic anti-fouling paints over the lacquer has been found to be injurious, the urushic acid of the lacquer sometimes attacking the metallic base of the paint, resulting in the practical destruction of the useful qualities of both. This preparation was developed experimentally, and test-plates coated with both protective and anti-fouling lacquers having given most satisfactory results immersed in sea-water at Yokosuka for eighteen months, the Japanese Admiralty ordered the lacquering of the new despatch-vessel *Yaeyama* with both kinds of lacquer. The work was performed in July, 1890, and the result will be watched with interest, as the test-plates remained perfectly clean; and if the same protection is afforded to the *Yaeyama* under the ordinary conditions of service, the anti-fouling lacquer will have vindicated its claim to be the equal if not the superior of any similar composition known.

The protective or anti-corrosive lacquer is mainly lacquer, small quantities of some inert minerals like mica or kaolin being added to increase the covering power and body of the preparation. The composition of the different coats differs somewhat, that applied directly to the skin of the ship containing the largest proportion of lacquer.

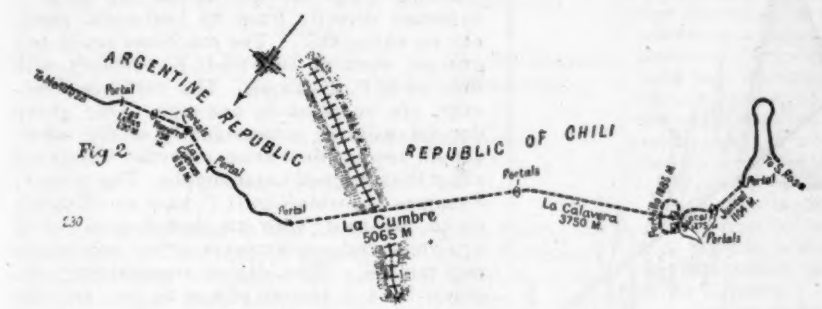
TUNNELING PLANT ON THE TRANSANDINE RAILROAD.

(From the London *Engineering*.)

THE principal difficulties found in constructing the Transandine Railroad, which is to complete the connection between the Atlantic and Pacific through the Argentine Republic and Chili, are found in tunneling and the overcoming of great differences in level in the crossing of the Andes. The total length of the new line, to which reference has already been made in our columns, from Mendoza to Santa Rosa in Chili, is 149 miles, of which 109 miles are on Argentine territory, and owned by an English company—the Buenos Ayres & Valparaiso Transandine Railroad Company, limited, while the 40 miles in Chili are owned by Clark's Transandine Railroad Company. Mendoza is 2,376 ft. and Santa Rosa 2,704 ft. above sea level, but between these points the line rises to 10,460 ft. The tunnels, which are at the point where the line attains its highest level above the sea, extend in all 15 km. (9.32 miles), and to overcome a part of the difference in level within a short distance, and at suitable working gradients, it has been found necessary to construct a spiral tunnel 6,183 ft. long. Fig. 2, appended, is a plan of the works from Juncal, in Chili, to the Quebrada Navarro in the Argentine Republic, the distance by the line being about 14 miles. In this part of the line are included all the summit tunnels, and the altitudes are indicated on the profile, fig. 1. The greatest height attained by the railroad is 3,188 m. (10,460 ft.), while the summit level is 3,800 m. (12,467 ft.) above sea level. In that distance there are, as shown, eight tunnels, the longest being the summit tunnel, having a length of 5,065 m. or 16,620 ft. The spiral tunnel is at Portillo. The radius of the curve is 200 m., equal to nearly 10 chains. Of these eight tunnels, seven are in sidelong ground admitting of openings being made, so that a greater number of working faces are obtained, thus enabling the excavation to be done in shorter time than if working only from the ends. The maximum grade is 8 per cent., and this extends for a distance of 15 km. (9.32 miles).

It may here be stated that the tunnels are for single line, the area being 18.51 sq. m. (199,244 sq. ft.), the height being 5.30 m. (17.38 ft.); the width 3.40 m. (11.15 ft.); and the radius of arch 2 m. (6.56 ft.). A section is given in fig. 3. It is in the boring of these tunnels, or rather in the means adopted, that Messrs. Clark have overcome extraordinary difficulties, and a detailed description of the plant will be interesting.

The installation may be said to be unique, as it is probably the first time that the power for compressing air for the drills has been conveyed for such a long distance by electric cables. We may refer briefly to the reasons which made such an arrangement almost imperative. In the first instance the absence of fuel on the spot and the enormous expense which would have been involved in obtaining it, precluded the use of any but natural power for driving the air compressors. Secondly, since sufficient water power could not be obtained near the faces of the tunnels, which have to be drilled by machines, it was necessary to place the turbines where the power could be obtained and to transmit it to the compressors. Upon the advice of their engineer, Mr. Alfred Schatzmann, who had had great experience on the St. Gothard and other European tunnels, Messrs. Clark adopted an electrical transmission of power. Mr. Schatzmann planned the arrangement of the installations, and fixed the power of the machines required at each.



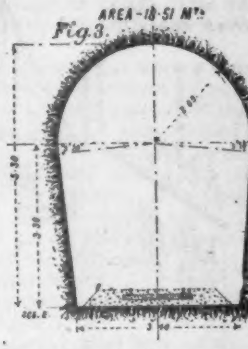
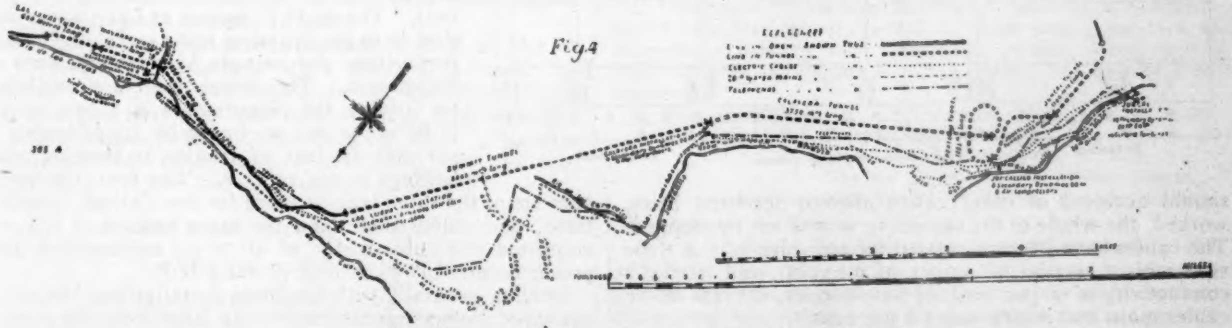


FIG. 3. SECTION OF TUNNELS ON TRANSANDINE RAILWAY.



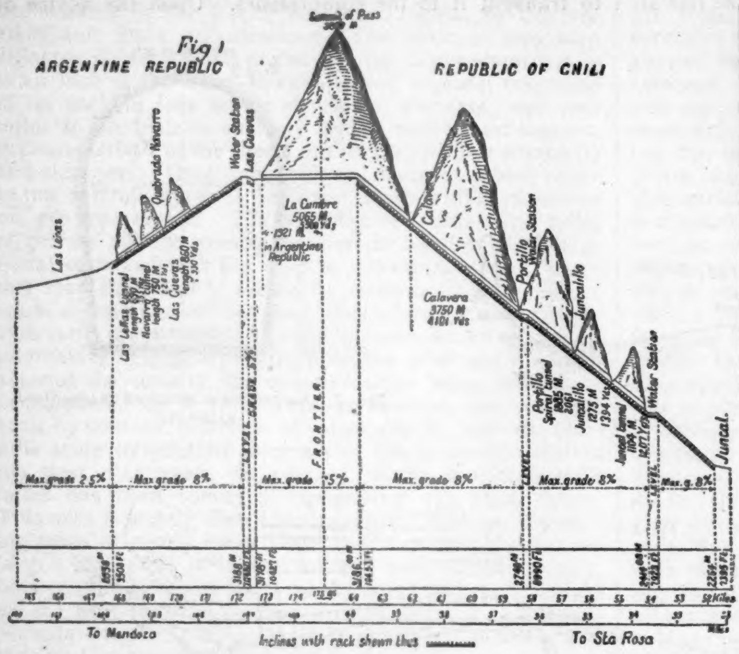
TUNNELS ON THE TRANSANDINE RAILROAD.

The disposition of the various departments of the works thus becomes matter of interest, and before dealing at length with the plant itself, we shall refer more particularly to its arrangements and general efficiency. Fig. 4 shows the districts in which the various works are placed. There are three installations, one upon the Argentine and two on the Chilian side of the Andes, each being distinct in all points, except that the primary stations on the Chilian side are both located at Juncal. Each installation has a primary station where the turbines and dynamos are situated, and a secondary station with electro-motors and air compressors.

The Chilian installation consists of two primary stations under one roof at Juncal, with secondary stations at Juncalillo and Calavera, as shown on plan, fig. 4. There are separate cables for transmitting power from Juncal to

Juncalillo and to Calavera. The power for driving the turbines is obtained from the Quebrada Juncalillo, the water being conveyed from the settling tanks to the turbines, a distance of 1,300 m. (about 4,260 ft.), by a double line of 20-in. diameter steel pipes.

The primary station at Juncal for this installation consists of six Girard turbines, each giving 80 H.P., effective at a speed of 700 revolutions per minute, receiving 50 litres per second (11 galls.) under a pressure of 170 m. head of water (557.8 ft.). The total power given out by the turbines is therefore 80 H.P. by 6 = 480 H.P. effective. Each 80-H.P. turbine is coupled directly on to the shaft of an 80-H.P. dynamo, consequently there will be no loss of power in transmission from the turbines to the dynamos. The dynamos, each absorbing 80 H.P., and working at 700 revolutions per minute, have an efficiency of 90 per cent., an electrical output of 400 volts and 135 amperes. They are grouped in two groups of three dynamos each, each group having a main and return transmission cable. A great advantage is gained in having two groups, as, should accident or other cause prevent one from being worked, the whole of the tunneling would not by stopped. The cables have been calculated for 400 volts by 3 = 1,200 volts with a section of copper of 0.233 in., and having a conductivity of 98 per cent. of pure copper, the loss in the cables main and return being 8 per cent.



The secondary station at Juncalillo is 3,000 m. (about 9,843 ft.) from Juncal, the power available being 2 by 3 by 80 H.P. by .91 by .92 = 401.8 H.P. At Juncalillo the cables are attached to six electric motors, similar to those of the 80-H.P. primary dynamos, but owing to the loss in the line they will only run at 600 revolutions. The motors have a commercial efficiency of 90 per cent., and the six will give a power equal to 401.8 H.P. by .90 = 361.67 H.P. The motors running at 600 revolutions per minute drive through a shaft, running at 300 revolutions, six air compressors at a speed of 180 revolutions per minute. Assuming the loss of power due to shafting and belting at 5 per cent., the power available for driving compressors is 361.67 H.P. by .95 = 343.58 H.P. The compressors, six in number, each take in 9 cu. m. of air (317.84 cu. ft.) at six atmospheres absolute (88 lbs.). Assuming that each cubic meter of air taken in and compressed to six atmospheres requires 6.15 H.P., the powers absorbed by the compressors will be 54 by 6.15 H.P. = 332.10 H.P., which, deducted from the power available, 343.586 H.P., leaves 11.486 H.P. available for the workshops and electric light.

The installation of Juncal-Calavera is very similar to the Juncal-Juncalillo, described above. The turbines are in the same shed, and take their water from the same source. These and the dynamos are also of the same size and power; but since the distance Juncal-Calavera is 7,000 m. against 3,000 m. for Juncal-Juncalillo, the power available at Calavera for driving the compressors is proportionally less. The cables, one main and one return, have a section of copper of 0.271 .in., and carry 1,600 volts (the product of four dynamos at 400 volts each, with a loss of 12 per cent. main and return). The power available, therefore, for driving the four compressors at Calavera, which are the same size as those at Juncalillo, is 4 by 80 H.P. by .91 by .88 by .90 by .95 = 219.10 H.P., the compressors requiring 6.15 by 36 = 221.4 H.P.

Turning now to the Argentine installation, the water-power upon this side is derived from the Quebrada Navarro, fig. 4, the water being conveyed to the turbines from the settling tanks, a distance of 350 m. (1,149 ft.) by a single line of 20-in. diameter steel pipes. Owing to the difficulties of transport upon the Argentine side of the mountains, 80-H.P. dynamos were found to be too heavy for transport, and machines of half the power were therefore adopted. At the primary station at Navarro, four Girard turbines similar to those at Juncal, but designed to work with a pressure of 115 m. head (377.3 ft.), with 75 litres of water per second (16.5 galls.), are used; these give each 80 H.P. effective at 700 revolutions per minute. Each turbine drives two 40-H.P. dynamos directly from its horizontal shaft, one on either side. The machines are in two groups, each of two 80-H.P. turbines with four 40-H.P. dynamos. The turbines, however, are supplied by one pipe. One group can be worked independently of the other, should any accident arise, provided it does not affect the source of water supply. The primary dynamos absorbing 40-H.P. have an efficiency of 90 per cent., with an electrical output of 250 volts and 107 amperes at 700 revolutions per minute. The cables transmitting the power have a section of 0.22 sq. in., and the loss in main and return between Navarro and Las Cuevas, a distance of 3,000 m., is 8 per cent. The 30-H.P. motors at Las Cuevas are similar to the dynamos at Navarro, and at 600 revolutions per minute have an efficiency of 89 per cent. The power therefore available for driving the compressors is 2 by 4 by 40 H.P. by .90 by .92 by .89 by .95 (allowing 5 per cent. for loss of friction in shafting and belting) = 224.74 H.P. The four compressors are of the same type as those for the Chilian installations, and calculating upon the same basis, 6.15 H.P. to compress one cubic meter of air to six atmospheres, the power required is 36 by 6.15 = 221.4 H.P.

Dealing generally with the three installations, the air is conveyed from the compressors into large steel reservoirs, and from thence to the drills in 4½-in. wrought-iron pipes. The drills are of the Ferroux type, are mounted upon carriages in groups of six, and are run forward on rails to the face. As the greater part of the tunnel is on a grade of 8 per cent., special arrangements have had to be made for clearing the débris. Where it has to be hauled forward to the open air winches are used; and where it may run out on a down grade arrangements are made whereby the full wagons draw the empty wagons to the face. The movements are controlled by special brake drums made by Messrs. Bradley & Craven.

The several stations are connected by telephone, and similar communication is established between the settling tanks and the turbine house, so that, although the works are widely separated, the same initial power, which is, by the various processes, converted into active work at the rock face, affords the means of instant and easy communication with all parts of the works. The workshops which, by the way, are built of stone found in the district, with wooden roofs sent from England, are lighted by electricity generated in a separate 10-H.P. dynamo.

The Girard turbines have been supplied by Messrs. Escher, Wyss & Company, Zurich, Switzerland; the dynamo and electrical motors by the Oerlikon Company, also

of Zurich, and the air compressors by Messrs. Burckhardt & Company, of Basle, Switzerland, firms formerly associated with somewhat similar work in connection with Swiss tunnels. The Ferroux drills were made by Messrs. Demange & Satre, Lyons, France, under the supervision of the patentee. The cables are by Messrs. Siemens.

Since the above was written, reports have been received from Buenos Ayres that the first three sections from Mendoza to Uspallata, 91 km. (56.546 miles), have been opened to traffic under the guarantee of the Government, and that the next section of 30 km. (18.641 miles) in length to Rio Blanco will soon be ready. This will bring the portion completed to 121 km. (75.187 miles), leaving 54 km. (33.5 miles) on the Argentine, and 42 km. (26 miles) on the Chilian side, on which the earthworks are well advanced, to complete communication between the Atlantic and Pacific oceans; 93 per cent. of the distance from ocean to ocean can now be traversed by rail, and the works are far advanced upon the remaining 7 per cent.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.*

CHEMISTRY APPLIED TO RAILROADS.
XVII.—PAINT SPECIFICATIONS (*Continued*).

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page* 225.)

Owing to sickness in the Laboratory force during the past month, it has been impossible to make the experiments necessary to decide the points referred to in the last article in regard to how properly to design a paint, and we therefore continue in the present article the subject of paint specifications, and will also have something to say concerning the livering of paint.

The next paint specifications issued in point of time on the Pennsylvania Railroad were the specifications for *Tuscan red.* They have been in service but a short time, and therefore have not been fully tested. This material, as is well known, is used as the standard color for passenger cars on the Pennsylvania system, both east and west of Pittsburgh. The specifications are as follows:

PENNSYLVANIA RAILROAD COMPANY.

Motive Power Department.

Specifications for Tuscan Red.

Tuscan red will be bought in the paste form, and the paste should contain nothing but pigment, oil and turpentine.

The proportions of the ingredients of the paste should be, as nearly as possible, as follows:

Pigment, 75 per cent. by weight.
Oil, 9 per cent. by weight.
Turpentine, 16 per cent. by weight.

The oil must be pure raw linseed-oil, well clarified by settling and age; new process oil preferred. The turpentine must be good quality, and as free as possible from resinous matter.

The pigment desired contains no hygroscopic moisture, and has the following composition:

Sesquioxide of iron, 80 per cent. by weight.
Carbonate of lime, 5 per cent. by weight.
Organic coloring matter, 15 per cent. by weight.

Samples of dry pigment showing standard shade will be furnished, and shipments will be required to conform strictly to standard. The shade of paint being affected by the grinding, the P. R. R. standard shade is that given by the dry sample sent, mixed with the proper amount of oil and turpentine and ground, or better rubbed up in a small mortar with pestle, until the paste will pass the test for fine grinding. It is best to use fresh samples of the dry pigment for each day's testing. The comparison should always be made with the fresh material, and never with the paint after it has become dry. The comparison is easiest made by putting a small hillock of the standard paste and of that to be compared near each other on glass, and then laying another piece of glass on the two hillocks, and pressing them together until the two samples unite. The line where the two samples unite is clearly marked, if they are not the same shade.

The paste must be so finely ground that when a sample of it is thoroughly mixed, five [5] parts paste to three [3] parts of pure raw linseed-oil by weight, and a small amount of the mixture placed on a piece of dry glass, and the glass placed vertical, there will be no separation of the oil from the pigment for at least half an hour. The temperature affects this test, and it should always be made at 70° Fahrenheit. The sample under test runs down the glass in a narrow stream, when it is placed vertical, and it is sufficient if the oil and pigment do not separate for an inch down from the top of the test.

Shipments will not be accepted which

1. Contain in the paste less than 74 per cent. of pigment air dried at from 60° to 90° Fahrenheit.
2. Contain in the paste less than 8 per cent. of oil, dried at 250° Fahrenheit, or more oil than one-seventh of the weight of the pigment.
3. Contain in the paste impure or boiled linseed-oil, or more than 5 per cent. of moisture.
4. Contain in the pigment less than 75 per cent. of sesquioxide of iron, less than 2 per cent. or more than 5 per cent. of carbonate of lime, or have present any barytes, or any caustic substances, or any organic coloring matter, that has not been approved.*
5. Vary from shade.
6. Are not ground finely enough.

Theodore N. Ely,
General Superintendent Motive Power.

Office of General Superintendent Motive Power, Altoona, Pa., July 22, 1890.

It will be noted by those who are accustomed to the practices of the trade that these specifications for passenger car color made quite a radical departure from custom, since most fine colors used for passenger cars are ground in japan rather than in oil. It has been stated already in this series of articles that there was a radical distinction between carriage painting and house painting, and that in carriage painting it was essential that the color should be "flat" when dry, in order to take the varnish properly. The Tuscan red, of course, is used under varnish, and therefore it must dry "flat," and customarily japan has been used as the vehicle for the pigment. When we came to study this subject we found that the japans in the market were so varied in quality, and their examination so difficult, that we decided to make a radical step in the matter of carriage paints. As has already been said, our experiments indicate that the ratio of binding material to pigment is what determines whether a paint dries "flat" or dries with gloss, and we accordingly had our Tuscan red ground with just about enough oil, so that there will never be any difficulty about the color being "flat." This

* The above is one of a series of articles by Dr. C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad, who are in charge of the testing laboratory at Altoona. They will give summaries of original researches and of work done in testing materials in the laboratory referred to, and very complete specifications of the different kinds of material which are used on the road and which must be bought by the Company. These specifications have been prepared as the result of careful investigations, and will be given in full, with the reasons which have led to their adoption.

The articles will contain information which cannot be found elsewhere. No. I, in the Journal for December, 1889, is on the Work of the Chemist on a Railroad; No. II, in the January, 1890, number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils; No. VIII, in the July number, on the Method of Purchasing Oils; No. IX, also in the July number, on Hot Box and Lubricating Greases; No. X, in the August number, on Battery Materials; No. XI, in the September number, on Paints; No. XII, in the October number, on the Working Qualities of Paint; No. XIII, in the December, 1890, number, on the Drying of Paint; No. XIV, in the February number, on the Covering Power of Pigments; No. XV, in the April number, on How to Design a Paint; No. XVI, in the May number, on Paint Specifications. These chapters will be followed by others on different kinds of railroad supplies. Managers, superintendents, purchasing agents and others will find these Contributions to Practical Railroad Information of special value in indicating the true character of the materials they must use and buy.

* In view of the vast number of coal-tar products now available, whose properties are not yet definitely known, it has been deemed advisable, for the present at least, to ask those desiring to use any organic coloring matter as a constituent of Tuscan red, to submit a sample of the same, and receive approval for its use. This does not mean that each new lot of organic coloring matter obtained by the manufacturers must be approved, but that the kind of organic coloring matter used must be approved, and no change must be made in the organic coloring matter that has been once approved, unless authority to do so is given by this Company.

amount, however, is so small that it is impossible to get the pigment through the mill with the oil alone, and accordingly turpentine is added in order to make the material grind. This use of oil in place of japan requires some special arrangements in the mixing of the paint, and these arrangements are covered by the circular given below. As said above, very few difficulties have thus far arisen with regard to this paint, although many of the painters are so accustomed to the use of material ground in japan that they still prefer it. Of course they use the material according to specifications.

In a large system like the Pennsylvania Railroad, where shops are supplied from different portions of the country and by different manufacturers, it was believed that it would be practically impossible to get uniformity of shade if the shipments were ground in japan. Moreover, for the same shop supplied by two different makers the successive shipments differ a little in proportions and kind of japan, and consequently with each new shipment a new method of manipulation must be learned in the shop. These difficulties have been largely obviated, it is believed, by the standard specifications, and now a shipment of Tuscan red anywhere on the whole system is, within reasonable limits, the same thing.

The same remarks made use of in the last article, in speaking of *freight car color*, apply equally well to the oil used in grinding Tuscan red—namely, new process oil is preferred, because it is more apt to be free from mucilaginous matter. Thus far no difficulties have arisen over the quality of turpentine used, and although the specifications require turpentine as free as possible from resinous matter, there are some unworked-out problems in regard to the influence of rosin or pitch in turpentine which we are hardly able at present to give any definite information upon. Some painters prefer what is known as rather "fat" turpentine, which means turpentine which has oxidized somewhat, or which contains some pitchy matter. In order to get the conditions as uniform as possible with successive shipments, we have tried to have this material excluded.

It will be observed that in this pigment quite a contrary view is taken than was maintained in regard to freight car color—namely, as much as possible of the pigment is coloring matter, and as little as possible is inert material. This is believed to be entirely philosophic, and to have good reasoning back of it. In freight car color the inert material is used in order to increase the volume of pigment in the paint, and thus add to the durability, and also because inert material is usually cheaper and more durable than the specific colors; so enough coloring matter is used to give the desired shade, and the rest of the pigment is made of inert material. Not so, however, with *passenger car color*. Here the color is the only thing wanted, since we do not at all rely on the Tuscan red to protect the surface. The protection is obtained from the varnish, which is put on over the color, and, as is well known by every practical railroad man, when the varnish has gone the color is of little account. In brief, in passenger car painting, as in carriage painting in general, the color desired is put on to the prepared surface and is covered and protected from the weather by a special liquid called varnish, so that the necessity and desirability of inert material does not exist. Accordingly we make our passenger car color as high in coloring matter as possible. The material is usually applied in very dilute form, giving very thin coats, and these coats follow one another rapidly. The object of this is to get the surface well covered with color, and at the same time not have it too long in drying, it being found that three thin coats dry much more rapidly than two thick coats.

We have some experiments with passenger car color low in coloring matter. These show that three thin coats of such paint very frequently give a streaked job, owing to the scarcity of the coloring matter, and to such an extent is this the case that many of the Tuscan reds of the market, which are quite largely diluted with inert material, cannot be used successfully with the practice which prevails in the Pennsylvania Railroad Shops—namely, of using three thin coats of color.

The special shade of Tuscan red is usually obtained by taking Indian red and brightening it with some organic coloring matter. The organic coloring matter most frequently used is what is known in the market as *chatemuc*, or *wood lake*, which, as we understand it, is an extract of dye woods of various kinds precipitated with alumina or tin salt, the tin salt giving the preferable pigment. Indian red, as is well known, is largely sesquioxide of iron, and it is only necessary in making the P. R. R. Tuscan Red to take a good rich Indian red and add the proper amount and kind of wood lake. Other coloring matters are, however, approved for use, notably the *alizarin lake*, which may be quite easily obtained in the market. *Carmine lake* and *madder lake* are both moderately expensive, and apparently the amount required is so great of these materials as to make their use almost prohibitory in view of the price. We are, of course, constantly experimenting with new coloring matters, and stand ready at any time to approve any new coloring matter which seems to have a fair amount of durability in it. Meanwhile, we are obtaining such material as is needed by the use of chatemuc and alizarin lakes.

The same remarks made use of in the last article on freight car color, in regard to shade, apply equally to Tuscan red. Practically, we do not find absolute uniformity in successive shipments from the same makers, nor in shipments of the same material from different makers. The shades, however, are sufficiently near to identity, so that two cars painted with different shipments from the same manufacturer, or with shipments from different makers, standing side by side would hardly have difference enough in shade to excite attention. Until our specifications were issued this was certainly not true, as cars from different shops supplied by different makers frequently showed wide differences in color.

The test for fine grinding of Tuscan red is the same as that made use of in freight car color, except the proportions are different. The limits toward the bottom of the specifications which decide for what causes shipments will be rejected are perhaps clear and easily understood. No upper limit of amount of pigment is given, as, if the limit of oil is followed, it is immaterial to us how much pigment is used, and the necessities of grinding are usually what limit the amount of pigment.

The limits of oil in the specifications are from 8 to 12½ per cent., and thus far we have had no occasion to complain of shipments varying outside these limits. The turpentine, of course, fills out the 100 per cent. after the proportions of pigment and oil are specified, and we put no limit on this, allowing each maker to use whatever he might find necessary in order to get the pigment through the mill, except that the pigment and oil limits must be filled. The reason why we prefer the raw oil instead of boiled oil will be given when we come to finish up the discussion of the question, "How to Design a Paint," since it properly comes in that article, under the heading, "What Liquid Shall be Used?"

The reason for the use of carbonate of lime in Tuscan red is exactly the same as with freight car color—namely, much of the Indian red is or may be made by the ignition of sulphate of iron, and it is possible not all the acid is driven off, and our experience, as has been previously stated, indicates that a little carbonate of lime facilitates drying. The kind of organic coloring matter has already been discussed, and we will only add here that there are such a large number of reds made with some of the coal-tar products as a basis which are fugitive, that we have felt compelled to protect ourselves against these by the requirement that we must be furnished with a sample, and have a chance to test any new organic coloring matter that it is proposed to use in this paint.

The instructions for mixing Tuscan red are as follows:

PENNSYLVANIA RAILROAD COMPANY.

Motive Power Department.

No. 84.—*Instructions in Regard to Mixing Tuscan Red for Passenger Car Color. Superseding Circular issued July* 23, 1890.

The Tuscan red heretofore used has been almost universally ground in japan. This practice will be abandoned, for all Tuscan red purchased in accordance with the P. R. R. Standard

Specifications, and the Tuscan red furnished will be ground instead in oil and turpentine. This change in the composition of the paste will necessitate some changes in the method of mixing. The following formula is found to work satisfactorily at the Altoona Car Shops:

Tuscan Red (P. R. R. Specifications)....	10 lbs.
Coach Makers' Japan....................	2½ pints.
Rubbing Varnish........................	1½ "
Spirits Turpentine.....................	5 "

There is some difference in the japans in the market, and it is also probable different localities require different proportions in order to secure satisfactory drying, and proper results when the varnish is applied. Each shop is therefore allowed a certain amount of discretion in proportions according to the japan used and the locality in which it is situated.

In matching old and faded color, it is of course expected the standard Tuscan red will be toned with other materials to secure the shade. Two parts burnt and one part raw Sienna, with a trace of raw umber, when mixed with an equal weight of P. R. R. Standard Tuscan Red are found to approximate the color of Standard Tuscan Red that has been exposed to the weather for six to eight months.

THEODORE N. ELY,
General Superintendent Motive Power.

Office of General Superintendent Motive Power, Altoona, Pa., April 23, 1891.

It will be observed that these instructions have just been issued. The first edition, which was issued when the Tuscan red specifications were printed some nine months ago, were practically the same, except that no varnish was used, but it was found that some of the shipments of Tuscan red did not have quite binding material enough on the old formula, and accordingly a new formula was given. As is indicated in the instructions, considerable latitude is allowed to the different shops in this mixing, depending on the locality and on the different kinds of japan used. Recently our attention has been called to another peculiarity—namely, that a formula which works nicely with shipments from one manufacturer may not work with shipments from another manufacturer, although both shipments pass the requirements of our specifications. We are not yet fully prepared to explain this anomaly, but we are inclined to think it has something to do with the kind of organic coloring matter used, and also possibly that the fineness of the pigment exerts an important influence. All our experiments indicate that the finer the pigment the more binding material is required, and although our specifications give a test for fine grinding, they do not say that shipments shall not be finer than this test will admit of, so that if shipments are received from two different manufacturers, and one of them just passes test for fine grinding and the other is a great deal finer, it will undoubtedly be found in the use of these materials that the finer will require more binding material.

The chemical operations involved in the analysis of Tuscan red present no special points of difficulty. The oil and pigment are separated by means of gasoline, the pigment being washed with more gasoline two or three times by decantation. The gasoline is evaporated, leaving the oil for subsequent test. We use Maumene's and other tests for determining the purity of the oil. Of course, the weights of the separated oil and pigment are taken. The amount of oxide of iron in the pigment is determined in the volumetric way by means of permanganate of potash, or standard bichromate of potash. The details are entirely familiar to every chemist, and do not need special remark. The carbonate of lime is determined by taking a definite weight of separated pigment and determining carbonic acid by loss, calculating this as carbonate of lime. The method is not entirely free from objection, but will give results with careful manipulation within a small fraction of error. The amount of water present in Tuscan red is determined by taking a weighed portion of the original paste and adding to it a weighed amount of dehydrated sulphate of copper. Another portion, same amount of the paste is weighed out, and no sulphate of copper added. Both the portions are then treated with gasoline, and the oil separated completely. The material remaining behind in the flask is then dried by aspirating dry air through the flasks, and both flasks with their contents are then weighed. The water, if any is present, passes off during the aspiration through the flask which contains no sulphate of copper, while the water, if any is present in the flask containing the anhydrous sulphate of copper, is retained by the sulphate of copper, and increases the weight. The increase in weight, of course, shows the amount of water. This method gives fairly satisfactory results, and is perhaps accurate to 0.10 or 0.20 per cent. The method for distinguishing the various organic coloring matters present in the Tuscan red may be found described somewhat at length in special treatises on this subject. We are using partially methods which we ourselves have devised, and partially well-known methods given in the treatises. These methods are somewhat lengthy of description, and would perhaps hardly be worth the space they would occupy in this series.

XVIII.—THE LIVERING OF PAINT.

FROM time immemorial all painters have occasionally been annoyed by finding a bucket of paint which had been mixed up ready for spreading over night, so thick the next morning that it could not be used. The material in the bucket could be cut out in lumps and looked like liver, and consequently this behavior has received the name of "livering." The peculiarity is too well known to require further description. The causes which have been assigned for this remarkable behavior have been very numerous, and its erratic and puzzling occurrences have led many to regard it as one of the unsolved and unsolvable mysteries of painting.

Studies on this subject in the Pennsylvania Railroad Laboratory, some two or three years ago, indicated that this peculiarity was related in some way to the water chemically combined with the sulphate of lime in the pigment, and in the specifications issued March 25, 1887, an attempt was made to overcome the difficulty by having the pigment dried at 250° Fahrenheit. This drying at 250° Fahrenheit removed a portion of the water chemically combined with the sulphate of lime in the pigment, and proved an effectual remedy for livering, provided the paint mixed with large amounts of strong japan was not allowed to stand over 24 to 36 hours. But with paints mixed ready for use of course much longer time is necessary between the mixing and the spreading, and on attempting to make some ready mixed paint the old difficulty appeared. This has led to renewed study of the subject, which study indicated as follows: Gypsum, or hydrated sulphate of lime, contains two molecules of water. When this material is heated to the proper temperature more or less of this water is driven off. In this condition the sulphate of lime is known as plaster of Paris, which is one of the well-known commercial forms of the article, and the form in which some of it finds its way into paint. Still further, Venetian red made by modern methods contains a large amount of sulphate of lime, which, since it has been retorted, may have only a small portion of the water necessary to form gypsum or fully hydrated sulphate of lime. If now, as is well known, either dry plaster of Paris, or plaster of Paris mixed with iron oxide or other pigment, or dry Venetian red not fully hyhrated, or the same Venetian red mixed with other pigments, or a mixture of dry plaster of Paris, iron oxide and Venetian red, such as is frequently used in making the Pennsylvania Railroad shade of freight car color, are treated with water, the sulphate of lime takes up water and sets, the hardness of the setting being proportional to the amount of not fully hydrated sulphate of lime present before treatment with water. This has been proved by repeated experiments, and it seems safe to conclude in general that if a pigment containing sulphate of lime not fully hydrated can get water from any source there will always be a tendency for it to assume a more or less solid form.

Turning now to such pigment as is above described mixed with oil and japan, Mülder has suggested that during the drying of linseed-oil water is formed and given off —a fact which helps to explain the slow drying of paint in damp weather. The atmosphere, being nearly saturated with moisture in damp weather, does not as readily take up the water formed during the drying of the oil, and the getting rid of the water formed being an essential to drying,

the operation is retarded. Furthermore, it is possible the same thing is true with regard to linseed-oil containing japan—viz., water is formed during the drying, and some believe that when large amounts of strong japan are mixed with linseed-oil water is immediately formed throughout the mass by reaction between the japan and oil. If now there is pigment present containing more or less sulphate of lime not fully hydrated, this sulphate of lime takes up the water as it is gradually formed, with the consequent tendency to set. The presence of the oil and japan of course prevents the material from setting to a hard stony mass, as when only pigment and water are present, but, as is well known, livered paint is not a hard mass, the liver being more or less hard, apparently in proportion to the amount of sulphate of lime which gets water present in the paint. According to this explanation, therefore, livering is the setting of the sulphate of lime in the pigment as far as is possible for it to do so under the circumstances, the water necessary being in most cases furnished by the reaction between the oil and japan in the mixed paint. Of course a wet bucket, or water accidentally introduced, will produce the same result. If the above reasoning is correct there will be no livering if the sulphate of lime is in such a condition that it does not take up water, or if the amount of water furnished is too small to cause the material to set. This latter alternative explains why pigment dried at 250° Fahrenheit does not liver in 24 to 36 hours—viz., not enough water is formed during that time by the reaction between the oil and japan to cause the change to take place. But, as already stated, drying the pigment does not, in general, prevent the difficulty for a longer time than this.

Two other methods of securing the desired end present themselves—viz. : (1) It is claimed that if sulphate of lime is heated to or above a red heat, it will not again take up water. To do this, however, is both expensive and uncertain, as it is well known that there are certain substances which might occur as impurities in the pigment that would make sulphate of lime capable of enduring red heat without losing its power of taking up water and setting. (2) It is obvious, provided the explanations above given are correct, that if the sulphate of lime in a pigment has taken up all the water it requires before the pigment is ground with oil there will be no further trouble from livering when the paint is mixed ready for use, and this view of the case is confirmed by many experiments. The hydration of the pigment being simple and inexpensive, we have accordingly decided to ask in our specifications for a pigment in which the sulphate of lime is fully hydrated.

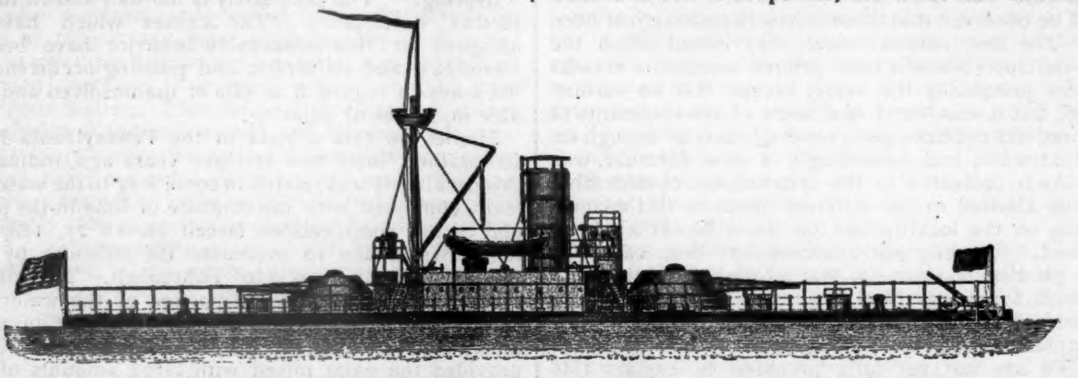
As the result of considerable experimentation, a successful method of introducing the water has been found, which is as follows: Weigh or measure into the chaser the amount of oil required for the batch of paint that is to be made. Add to this the amount of water required to fully hydrate the pigment, and start the chaser in operation. An emulsion is formed between the water and oil. Now add the carbonate of lime required for the batch of paint, keeping the chaser in operation all the time, and then add in any convenient way—probably best by the shovelfull—the balance of the pigment. By this method the water and the carbonate of lime are uniformly mixed throughout the whole mass of paint, and no hard lumps of pigment are formed, to be subsequently reduced to a fine state of division by the grinding. The easiest method of determining how much water is required to fully hydrate the pigment is to weigh out one-half ounce of it, and put it in any convenient vessel in a thin layer. Then sprinkle it thoroughly with water, and allow it to stand over night, until all the water evaporates. The increase in weight will show approximately how much water is required. It will be observed that our specifications for freight car color allow for an excess of 2 per cent. of water over what is necessary to fully hydrate the pigment, and the specifications for Tuscan red allow an excess of 5 per cent. These limits, of course, must not be exceeded, but it is not objectionable to have a small amount of water present in the paste when shipped.

The explanation given above of the philosophy of livering of paint has been criticised somewhat by parties to whom the information was communicated, but no other information has been suggested which would account for the facts. The main criticism was that other pigments than those containing sulphate of lime would occasionally liver, notably white zinc, and possibly one or two other substances. We made experiments with white zinc, and found that when dry, white zinc was mixed with water and the water allowed to evaporate, the white zinc caked and became very hard. It would seem, therefore, that the presence of water would explain the livering of white zinc in the same way that it explains the livering where sulphate of lime is present. We are quite well aware that red lead sets very hard in a bucket when mixed with oil, and this may be regarded as a species of livering. We do not, however, regard this as being explained in the same way.

The philosophy of the setting of red lead is, we think, due to chemical reaction between the oil and the lead, although we have not made experiments enough to positively say this is the case. With red lead two chemical reactions are possible—namely, a combination between the litharge of the red lead and the glycerine of the oil, and also a combination between the litharge and the fat acids of the oil, resulting in the formation of lead soap. It is well known that glycerine and red lead make a very good hard cement, and also it is well known that lead soap is in itself quite a firm substance, so that it is possible both these reactions may take place, and if so they would explain the setting of red lead. It is possible, still further, that the livering of white zinc may be due or assisted by chemical reaction between the oil and the zinc, since we find by actual experiment that white zinc combines with the free fat acid in linseed-oil quite readily, even at ordinary temperatures, forming a zinc soap which would have a tendency to stiffen the mixed paint.

In the next article we hope to discuss the deferred question.

(TO BE CONTINUED.)



COAST DEFENSE SHIP "MONTEREY," FOR THE UNITED STATES NAVY.

THE UNITED STATES NAVY.

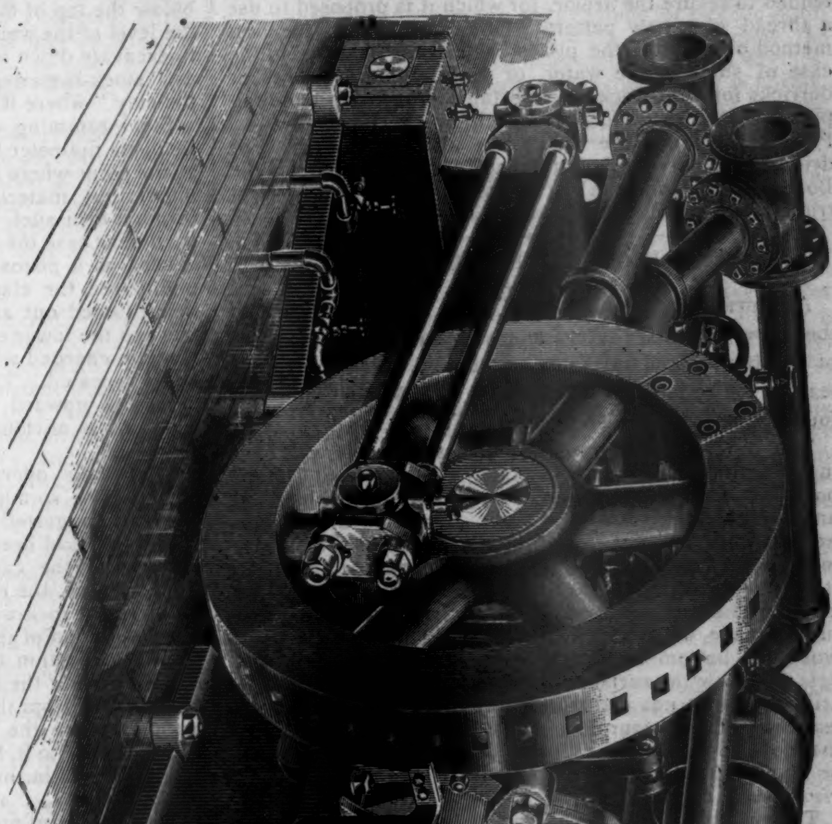
THE coast defense ship *Monterey* was successfully launched from the yard of the Union Iron Works, in San Francisco, on April 28. The President of the United States was present at the launch. This ship has been heretofore described, but, as some changes have been made since the plans were first published, and as a matter of convenience, a condensed description is given herewith.

The general dimensions are: Length over all, 261 ft.; length on load water-line, 256 ft.; extreme breadth, 59 ft.; mean draft, 14 ft. 6 in.; displacement, 4,000 tons. The ship is of the monitor type, with very low freeboard, but differs from the monitors in having a central barbette.

The main battery will consist of two 12-in. breech-loading rifles mounted in the turret at the forward end of the barbette, and protected by 13-in. steel armor, and two 10-in. breech-loading rifles mounted in the turret at the after end of the barbette, protected by 11½-in. steel armor. The secondary battery includes six 6 pdr. and two 1-pdr. rapid-fire guns, and four 37-mm. Hotchkiss revolving cannon.

The hull of the ship is very strongly constructed throughout, and the bow is ram-shaped, and especially strengthened for ramming. The hull is protected by a belt of steel armor extending the entire length of the vessel, varying from 13 in. amidships to 8 in. and 6 in. at the ends. She has an armored deck 3 in. thick covering the engines and other machinery. The conning-tower, barbette and other parts are protected by heavy armor. The military mast has two tops, one carrying two revolving cannon and the other the electric search-light.

The engines are expected to work up to 5,400 H.P., and to give the ship an extreme speed of 16 knots an hour. There are twin screws, each driven by a separate engine, and the boilers and engines are carefully protected.



THE AIR COMPRESSORS FOR THE "TERROR."

THE AIR COMPRESSORS FOR THE "TERROR."

The accompanying illustration shows an air compressor of very compact type built for the monitor *Terror* by the Norwalk Iron Works Company, at South Norwalk, Conn. There are two of these compressors, each of the same size, and they are now completed and being put into the ship.

Each compressor is of 250 H.P. The intake air cylinder is 28 in. in diameter, and the compressing cylinder 17½ in. The ordinary pressure will be from 100 to 150 lbs., but there is a supplemental cylinder by which the pressure can be carried to 2,000 lbs. if needed for torpedo or other service. The machines being for ship service, are necessarily made in compact form, and are only 14 ft. 4 in. long and 8 ft. 4 in. wide.

The *Terror* has four 10-in. breech-loading rifled guns, and the entire service of loading and elevating the guns, turning the turrets, taking up the recoil and bringing the guns again into battery will be done by compressed air. The advocates of this method claim that by reason of its great elasticity the air will do this work with less strain on the vessel than when hydraulic power is used.

The compressed air will also be used to refrigerate a cold storage room, to run the steering apparatus, hoist ammunition, and for other minor purposes.

GUNS AND ARMOR.

The Ordnance Bureau of the Navy Department has been making some tests of one of the new 10-in. rifled guns built for the double-turret monitor *Miantonomoh*. The tests were made at the new proving-ground at Indian Head, on the Potomac. In the heaviest charge this gun used 239 lbs. of powder, giving a pressure of 15 tons, while the projectile had a muzzle velocity of 2,116 ft. per second. This is the best result obtained so far with this class of guns. The fourth 10-in. gun for the

same ship is about finished at the Washington Navy Yard, and will shortly be taken to the proving-ground for test.

The Board appointed by the Secretary of the Navy some time ago to consider the best methods of fitting armor to ships has made an elaborate report accompanied by a number of drawings. This board consisted of Naval Constructors Phillip Hichborn and J. J. Woodward, and Professor R. R. Alger. Among the points considered in the report are the design of the bolts intended to secure the armor, for which it is proposed to use a thread of a new pattern. Other points are, the best method of handling the plates by floating derricks in the case of ships in the water, or by stationary cranes or derricks for it in dock, and portable cranes for handling plates in places difficult to reach by the larger cranes. Plans for holding the plates are also suggested. For drilling the hulls through the back and into the plates the Board recommends the use of portable drills run by electric motors, which can be carried anywhere.

STOPPING A COFFER-DAM LEAK.

A LETTER from Colonel O. M. Poe, U. S. Engineers, to the Cleveland *Marine Review*. gives an interesting account of the boring and ramming process by which the recent leak in the coffer-dam at the Sault Ste. Marie Canal was found and stopped. The letter says:

The coffer-dam referred to consists of a clay wall having a minimum thickness of 8 ft. This clay wall is supported on each side by a line of crib-work filled with stone, and therefore pervious to water. A portion of the dam extends from the west end of the north wall of the present lock up-stream along the middle of the canal for about 580 ft., and then turns squarely into the north bank of the canal. The leak occurred about 100 ft. east of where this turn is made, and was situated entirely beneath the crib-work, the bottom of which, at the site of the leak, was 22½ ft. below the surface of the water in the canal. The crib-work was not disturbed. At the deepest point the leak was at least four feet below the bottom of the crib, therefore 26½ ft. below the level of the water in the canal, or about 9 ft. *lower than the level of the water in the river below the lock.*

The rush of water underneath the dam was so great that bales of hay and gunny-sacks filled with clay thrown into the cavity were carried through. By driving sheet-piling on the down-stream side of the space from which the clay wall had been carried away, a sufficient obstacle was established to prevent hay in bales and clay in sacks from being washed through, and after some 2,000 sacks of clay had been thrown in it became possible to fill the gap with loose clay. But the leak still remained too large for the pumps to handle, and to further reduce it, as well as to get something into place more substantial than the sheet-piling which had been driven at first, timbers 12 in. square, sharpened to a chisel edge at the lower end, and shod with iron to the extent of the ability of the entire blacksmith force at the Sault to manufacture, were driven with a 1,900-lbs. ram between the sheet-piling and the crib-work, until they could be driven no further, when it was assumed that they were in contact with the rock formation, and a note made of the depth to which they had gone. The clay wall was then loaded with heavy piles of stone to compress it, and the result was a reduction of the leak to such a degree as to bring it easily within the control of the pumps, and nineteen days after the break the lock-pit was again empty of water. The volume of water in the pit was about 45,000,000 gallons, and this, in addition to the leakage, was handled by the pumps in less than seven days.

Although the pumping capacity available was sufficient to easily keep the lock-pit empty, it was still very desirable that the leak should be entirely stopped, and it was believed that this could be done very soon after its exact location was ascertained. To find the crevice in the rock through which the water was passing, an iron rod was driven down through the clay wall, in front of and close to the timbers already referred to, until it would go no further. The depth to which it penetrated was compared with the depth to which the timber had been driven, and the proper notes were made concerning any effect upon the muddiness of the leak. The rod was then withdrawn, moved laterally, an average distance of 8 in., and again driven to the rock. This operation was continued until at one place the rod went 2½ ft. deeper than at a distance of 8 in. on either side of it. Here then was the crevice sought, and the next thing to be done was to fill it with clay or other water-tight material. It was nearly 30 ft. below the top of the clay wall, and more than 26 ft. below the level of the water in the canal. It was not practicable to excavate down to it, and no other mode than that known as "stock-ramming" seemed available by which to put the clay "where it would do the most good."

Stock-ramming consists simply in driving a tube of requisite diameter to such depth that its lower end will be at the point where it is desired to deposit the clay or other impervious material, and then forcing such material through it in such quantity as may be necessary. In this particular case the tube used is an iron pipe. An iron rod is used as a piston, and this piston is driven down by a pile-driver, the clay with which the pipe had been filled being forced out at the lower end. When the piston has reached the lower end of the pipe it is withdrawn, the pipe is again charged with clay, and the operation of forcing it out is repeated. This is continued until the clay rammed in forces upward the whole column of clay above it, when, as is obvious, the operation can be carried no further.

The whole operation is a simple one, and resembles nothing else so much as stuffing sausages, which, I dare say, first suggested its use many years ago.

The leak had been stopped before the ice had been gotten out of the canal. As soon as the canal could be cleared of ice, the movable dam was double-battened, the valves of the lock were opened, and for the first time since the completion of the present lock the water was drawn off from that portion of the canal below the movable dam. More than half the bottom was laid bare. The withdrawal of the water from the canal of course reduced the upward pressure upon the clay wall of the coffer-dam, and the mass of clay, 30 ft. high, compressed under its own weight as much as 18 in. in the case of the new clay put in at the site of the leak.

The successful manner in which this leak was dealt with greatly increases our confidence in our ability to control any which may occur in future, but it does not remove our anxiety. That will abide with us until we no longer need the dam. But we regard the dam as now better than ever before, and the experience gained will enable us, in case of any future leak, to apply the most efficient remedial measures in the shortest possible time.

It was never supposed that a work like this could be carried on, under all the surrounding conditions, without great difficulty and many annoyances. But for the necessity of providing for navigation while the new work is in progress, the work would be simple enough. All the trouble we have thus far encountered has arisen from this necessity.

THE DEVELOPMENT OF THE COMPOUND SYSTEM IN LOCOMOTIVES.

By M. A. Mallet.

(Paper read before the Société des Ingenieurs Civils, Paris; translated from the French by Frederick Hobart.)

(*Concluded from page 206.*)

OBJECTIONS TO THE COMPOUND LOCOMOTIVE.

WE propose now to examine in detail the different objections which have been and still are presented against the use of double expansion in locomotives. We cannot do better than to take for a guide in this task the paper of M. Polonceau, not that we place that eminent engineer among the opponents of the new locomotive, since he has always repelled such a charge, but because we find in his work collected and presented under a form readily understood the different arguments by which it has been sought

to prove that the advantages claimed for the application of double expansion on railroads were either not obtained, or if they were, were counterbalanced by more or less serious inconveniences. We will examine one by one the objections which are successively presented.

The first is the favorite argument of the opponents of the compound locomotive, and is an objection to the principle. They say "the service of locomotives is entirely different from that of stationary and marine engines. The work of a locomotive varies continually; but the compound engine is especially economical for a constant work, and seems to become less economical for any work other than that for which it has been adapted; in other words, what is good for the one may perhaps not be good for the other."

It is difficult to find the reason of the prejudice which many people have that the expansion in successive cylinders is not adapted to any notable variation of power. It is really only a prejudice, and both theory and practice agree in refuting this hypothesis when presented under a general form. We see, however, this objection always brought forward before all the others.

Let us then examine it with some care.

We will note first that the case of locomotives and that of stationary engines under the conditions of hard and variable work are entirely different. In the stationary engine the speed of travel must remain constant whatever the load, and it is then the work produced by a variable effort at constant speed which varies. In the locomotive, on the other hand, the speed changes continually, and in an opposite direction from the effort of traction, which is changed from one instant to the other according to the profile of the road. The work then does not show great variation; it is the effort of traction. If, moreover, it is said that the resistance of a train increases with the speed, chiefly on account of the resistance of the air, and that this speed can be considered within certain limits as inversely proportioned to the grade, we find that in most cases and for lines of moderate grade, the effort of traction does not vary within such wide limits as one would at first suppose.

Is it true that for locomotives the expansion of steam in two successive cylinders will not permit as great a variation of the total effort upon the pistons as if the expansion took place in a single cylinder?

In a locomotive with double expansion the maximum introduction of steam can be carried without difficulty to 85 per cent. of the stroke, and we need not reduce it below 25 per cent. because it is useless and we desire to obtain the most favorable conditions for distribution.

The limits of expansion will then be, for a ratio of volumes equal to two between the cylinders, from 2.35 to 8. If we neglect the counter-pressure and take the initial pressure equal to 1 we will obtain average pressures representing the total effort of .0788 and .0380 respectively; that is, 2.07 and 1. The ratio of these two figures represents the variation of effort which can be given theoretically by the variation of the admission. It is well understood here that the question is on this point and not at all on the reduction which can be obtained by the partial closing of the throttle valve.

For the ordinary locomotive we take as the extreme limits for the introduction of steam 70 and 15 per cent. The first is greater than that which is employed at any time except in starting and the second does not give good conditions of distribution, at least with the motions in actual use. The corresponding degrees of expansion are then 1.42 and 6.60, and if we carry this out, as above, we obtain average efforts of 0.949 and 0.435, giving a ratio of 2.18 and 1.

The pretended superiority of the ordinary machine is then expressed by the ratio 2.18 to 2.07, or 5 per cent. of increase in the possible variation of effort; that is in quantity, for as to the quality of work we see that this variation is only obtained on the condition of admitting as a maximum in the ordinary machine a degree of expansion less than $1\frac{1}{2}$, which is positively a ridiculous idea for cylinders receiving steam from the boiler at a pressure of 140 to 170 lbs. The preceding statement is approximate, but we do not believe that the opponents of the compound system can meet it by one more precise.

In a practical point of view the economical results given by the compound locomotive, which seem very difficult to contest in presence of a mass of facts, appear to give a final blow to the error which we are combating, since these machines unite the conditions, which are claimed to be incompatible, of small expense and of variable work. This blow was not the first, and this incompatibility so often alleged had already received other hard blows from experience with machines other than those of railroads. No one would pretend, for example, that hoisting engines, or engines used for running the dynamos for electric lighting are machines with constant work. Nevertheless, the compound system is applied to advantage to such engines, and with very favorable results as to economy. It is hardly necessary to bring instances in proof of this, since it would be difficult to choose one from the great number of examples.

It is not at all certain whether it is well to meet the entire variation in the effort of traction in a locomotive by varying the admission to the cylinder only, and that we should not use throttling to a certain extent. This is a question which is far from being solved. We believe that the reduction of pressure by the throttle valve gives better results on a compound locomotive, which has already a maximum of expansion below which the engineer cannot descend, than upon an ordinary locomotive, where he can by this means do away with expansion almost entirely.

Continuing our arguments we can hardly treat seriously the opinion that: "In order to make just comparisons, we should not take only trials made with locomotives of different systems, but those made exactly under the same conditions. In this manner only, economical results found are real."

This is precisely what many conscientious experimenters have done, among whose number it will be sufficient to cite De Borodine, Urquhart, and many others, who are certainly interested in eliminating from their comparisons every foreign element which can vitiate their conclusions; and it is because the conditions recited have been absolutely filled that the economical results obtained must be received as real, and that we must attach the greatest importance to the conclusions drawn by distinguished engineers after prolonged experiment made upon a considerable scale, and also sanctioned by applications every day more extended.

Again, it is objected that if we change a locomotive by increasing its adhesive weight, which was before too low in relation to its heating surface, we will evidently have economical results from the compound, simply from increasing this weight, and that such results prove absolutely nothing.

Such a case has been presented under exceptional circumstances; but it seems difficult to admit that a change of 2,000 or 2,200 lbs. in weight in certain engines, which did not increase sensibly the adhesive weight, can explain a saving in fuel of 15 to 20 per cent. Even if this should be so, would not this be simply a cheap method of adding to the power of ordinary locomotives, and open a wide field of economy which we must have been very wrong to neglect until now?

The observation which we have just made answers the objection made that "to obtain a real economy it would be necessary to take account of the water saved, of the water used, to consider the cost of fuel and water for difficult loads and speeds, and to be careful to use fuel of the same quality, to have engineers of equal ability, and to take account of the influence of time, etc."

It is sufficient to refer to the memoir of M. de Borodine to show with what scrupulous care these conditions have been observed.

In a general way, when one or several compound engines are put in service with others, from which they differ only because one of their cylinders has from 6 to 8 in. more diameter and does the same service, one would suppose that the economy obtained is not the result of chance or of entirely foreign circumstance, especially if the comparison has extended over a long period.

Another objection is that "new machines, when they are new, made the subject of particular care by their inventors, with carefully chosen engineer and fireman,

always show a considerable economy, and when they are left to themselves, with a more or less capable engineer, as with ordinary engines, they often do not show more than 50 per cent. of the economy found upon a special trial."

This observation is a very just one; but we do not see how it can be applied outside of certain cases to compound locomotives rather than to others, such as those having improved valve motions, etc. We could, on the other hand, reverse the proposition and say that when a machine gives good results when beyond all control or interference of its inventor or manufacturer, and managed by the ordinary engineers of the line, who have no reason whatever to be interested in it, and indeed are apt to look with more or less doubt at new things; when the service is prolonged beyond the period during which the engine can be considered new, or when perhaps the engine, before being altered, had already seen 15 or 20 years of service; when all these conditions present themselves, we certainly ought to have a double faith in the value of the results entertained. This is a case which has been found presented in my own experience, for example, in Russia, in Switzerland, on the departmental railroads, and elsewhere.

M. Polonceau does not believe that the economy obtained by the compound system can be over 5 to 8 per cent., but he gives no reasons which have led him to this conclusion in presence of the 15 to 20 per cent. saving obtained by experimenters who have merited entire confidence. It is clear that if the compound engine has been used under conditions exceptionally favorable with relation to the others, we must be very cautious in deducing general conclusions from the results obtained, but in practice it is just the contrary, because it is presented as we have shown. So far as concerns the influence of the engineer and fireman, it certainly exists; but when the compound engines are managed successively by several engineers taken at random, and the economy in fuel is kept up; when the engines run over different lines, sometimes at a distance from each other, and having different profiles, although owned by the same company, and still the same results are obtained; when the engineers have to run alternately a compound and an ordinary locomotive and always obtain a considerable saving with the first; finally when the least consumption of the compound, as officially reported, shows a notable reduction of 10 to 15 per cent., for example, of the amount of fuel allowed to these engines in comparison with ordinary engines running in the same service, the influence of the engineer seems to have practically disappeared in determining the result.

M. Rodieux, Chief of Motive Power of the Jura-Simplon Railroad, said recently that in his opinion, and according to the facts which he observed in service, the use of compound working annulled in great part the influence of the engineer on the consumption of fuel, the compound always having a considerable minimum of expansion, 2.30, for instance, instead of 1.40, as we have previously shown, without the engineer being able to interfere. His opinion is of great importance. I hope that these facts, proofs of which I have in my possession, will be sufficient to convince some of my opponents.

Besides these objections, it is claimed that certain advantages attributed to the compound have not been really obtained. This point can be discussed very briefly, and really seems to rest in part on a misapprehension. The ease of starting, the better exhaust, and the stability of the compound are questioned, and it is denied that the compound is in better condition than the ordinary engine in these respects. I do not believe that any one has ever claimed this, at least under such form. In the beginning the enemies of the double-expansion locomotive based their objections upon these three points. It could not start; its exhaust was not free, and it was defective in stability. Experience has proved that all these amount to nothing. Now the ground has been shifted, and the superiority of the compound engine on these three points is contested; that is to say, its enemies admit that it is not inferior. For my part, I am not disposed to ask more.

There is, however, something to be added for starting. In reality the double-expansion engine is under superior conditions on this point, because with well-proportioned ordinary engines, under tolerable conditions of steam pressure, we should never run at more than 50 per cent. admission. It is only the necessity of being able to start in any position which obliges us to carry the maximum admission to 70 per cent., and to give consequently greater variation to the distribution than would be necessary for the regular running of the machine. In the compound, on the other hand, the high introductions can be used in ordinary running, and put us under very favorable conditions for starting. It is of course understood that the engine has proper starting apparatus.

As to the question of stability, some distinction is to be made. It is necessary to know what compound engines are spoken of. A point in which the superiority of a compound engine is incontestable is that for the same degree of expansion of the steam the moments of rotation around the axle show less variation, and that in consequence of other things being equal, we can employ a higher co-efficient of adhesion. It is this superiority and that which results from the lower value of the maximum strain in relation to the average strain undergone by the parts of the machine which are important. Thus one part in transmission of a steam engine, as a piston-rod or connecting-rod, taken upon an ordinary engine, will transmit an average strain much more considerable on a compound engine because that average strain can be brought nearer to the maximum strain, taken as the same in both cases, which the piece has to transmit. This is one of the considerations which led to the use of the Wolff type on the Northern Railroad of France. Now neither steam jackets nor superheating nor improved systems of distribution could give such advantages.

It is not to be denied that in the double-expansion locomotive, having for the same total expansion longer admissions in each cylinder and a wider opening of ports, there is less wire-drawing of steam than in the ordinary engine. It is useless to say that this inconvenience in an ordinary locomotive can be remedied by special systems of distribution, because innumerable solutions of this problem have been proposed during the last 15 years without any practical result. If the compound locomotive is a complication, would not the use of special valve motions, such as the Corliss, be a still greater one?

Really, as one of our Russian colleagues has expressed it, "The only complication involved in the compound locomotive is the increase in the diameter of one of the pistons, and the addition of a starting apparatus which is of very slight importance. Certainly the addition of complex and delicate apparatus to the ordinary locomotive, requiring an increase in expense of lubrication and maintenance, without counting the chance of breakage, even should these devices be completely successful, will only realize partially the object which is obtained in a much simpler way by the compound engine."

The changes made in stationary engines are very significant. The improved valve motions—Corliss, Sulzer, Wheelock, etc.—were at first adapted to single-cylinder engines, but to-day their inventors apply them on compound and triple-expansion engines, as was shown in a number of instances at the Exposition in 1889.

The diminution of interior condensation is one of the causes of the economy obtained by dividing the expansion between two successive cylinders. This is a well-established fact. We do not dispute that the exchange of heat between the walls of the cylinder and the steam may be modified in importance by the rapidity of the working of the machine, but to conclude, from that fact, that in a locomotive the influence of the compound in point of view of condensation can be taken into account is altogether another thing.

As long ago as 1850 Mr. D. K. Clarke found in locomotives, at the end of the expansion, an increase in the quantity of steam present in the cylinder, which could only be attributed to the revaporization of condensed water during the period of admission. These well-known experiments are the first by which this fact has been established on railroads, and they were further confirmed in France by the experiments made on the Orleans Railroad about 1852. The experiments made in 1867 by Herr Bauschinger on the locomotives of the Barbarian State Railroad will show the importance of this phenomenon. He found there an

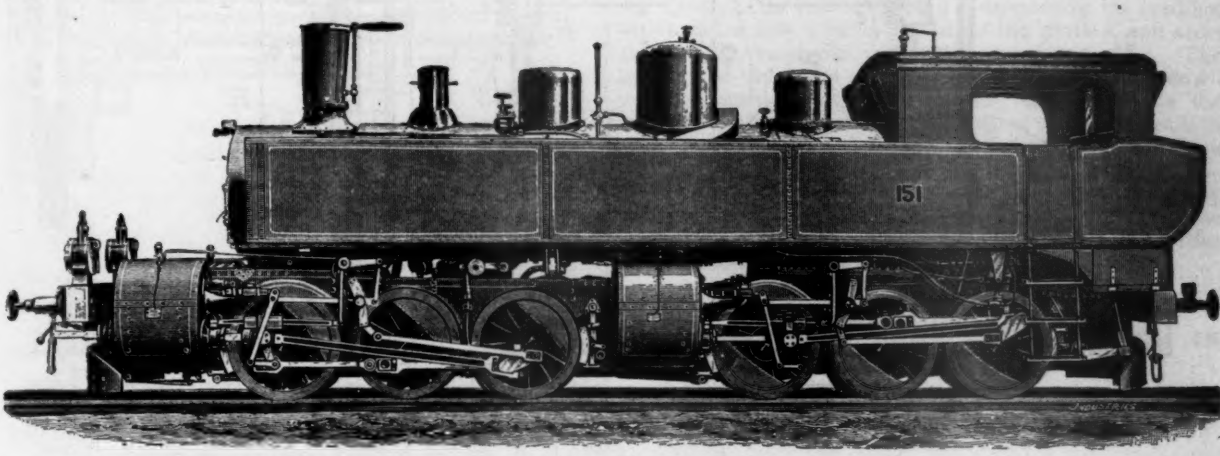
increase exceeding 100 per cent. in certain cases, and which only in exceptional cases descends below 20 per cent. between the quantity of steam present in the cylinder at the commencement and at the end of the expansion in locomotives in which the number of revolutions per minute varied during the trials from 80 to 180. Now, at this last speed, which can be considered as normal, the increase in the weight of steam during the period of expansion is indicated at 20 per cent., and that for a very partial cut-off, 37 per cent. At 157 revolutions, with the admission reduced to 23 per cent., the increase in weight of steam rose to 67 per cent.

Analysis of diagrams taken during the experiments of M. de Borodine, give the quantity of water revaporized during expansion, varying from 8 to 19 per cent. of the weight of the dry steam contained in the cylinder at the time of the cut-off.

We may here recall that the compound engine is used in a number of cases as a rapid-running engine, such as in electric light motors, torpedo boat engines, and others for the deficiency of which we have spoken. It must be understood that we must still seek by other means to prevent the exterior cooling of the cylinders, and of all the parts through which the steam circulates; but this is an independent matter, and cannot be cited as an objection to the use of the compound, since it applies to all machines.

We now arrive at a point where we must meet this claim: "The two-cylinder compound cannot have cylinders of sufficient volume, therefore it is not economical; it is, therefore, necessary to use more than two cylinders, and then the economy of fuel will be counterbalanced by the increase in expense of construction, of lubrication, and of maintenance."

We have already sufficiently proved that the fears relative to the insufficiency of the dimensions of the cylinders of the two-cylinder compound are exaggerated, and that this type suffices for almost all our present needs. The 750 engines of this model in actual service offer a sufficient proof. If we are obliged to recur to the use of more than two cylinders, it would be to obtain some advantage be-



ARTICULATED COMPOUND LOCOMOTIVE FOR THE GOTHARD RAILROAD.

where the piston speed is greater than that of locomotives. The remarkable experiments of Mr. Willans show that at 400 revolutions a minute this action of the walls of the cylinder is not annulled, and the experimenter concluded that with a non-condensing engine working at this speed it is worth while to employ the compound, even with boiler pressures not over 80 lbs.

We might again cite a very curious experiment in which the influence of interior condensation has been placed directly in evidence in a way which gives room for no doubt. In a trial made by M. Pulin, on the Northern Railroad of France, of a compound engine with equal cylinders, proposed by myself in 1875—a plan proposed and taken up since with some modifications of detail by M. de Landsee—it was found that this engine, run by the same engineer and doing identically the same work, used notably less fuel while running with admission of steam in only one of the two equal cylinders, and the passage of that steam into the other cylinder, than with a direct admission of the steam into the two cylinders. This diminution of consumption, obtained with a considerably less expansion, could only be attributed to the diminution of condensation brought about by the reduction of the fall of temperature in the cylinders, the total surface of which in contact with the steam was the same in both cases. Can the less effect of interior condensation be compensated by the increase of cooling surface due to the presence of a large cylinder? I do not think so. In the case of the two-cylinder compound engine, the total area of the surface is about 25 per cent. greater than in the ordinary engines. The loss of heat by radiation, with cylinders sufficiently protected, is estimated at 5 per cent. On this basis the compound would have an inferiority of 1.25 per cent. as compared with the ordinary engine. If this loss is appreciable—and I do not believe that it is—this would prove that compound working gives still greater advantage than it has been credited with, since it will have to compensate yond the economy in fuel, such as the increase of power, flexibility, or, in a word, some new advantage which would compensate for the additional charges due to the complication of parts. We do not believe that any one would use four cylinders simply for the pleasure of making them when two would be sufficient. The increase of power, for example, should bring about, outside of the economy of fuel, a reduction in the expenses of traction—that is, train expenses; it would justify a reasonable increase in the cost of lubrication and maintenance. This is really the way in which the question should be considered. As a matter of fact, we can cite the result obtained with a compound engine on the Jura-Simplon Railroad, which, in a year's service, running about 22,000 miles, consumed 3.8 per cent. less of lubricating oil than the average of other freight engines in the same service; the engines being the same, with the exception of the compounding of the cylinders. It is well to note here that experience so far obtained in America has supported my conclusions. The two-cylinder compound in that country has shown considerable economy; and while the Webb engine has been less successful on the Pennsylvania Railroad, the Baldwin four-cylinder type promises to do much better. I may also note that the Master Mechanics' Association appointed last year a Committee on Compound Locomotives, which presented a very interesting report.

Among other advantages, we may mention not only the reduction in the weight of the fuel burned, but the fact that a reduction may be made in the heating surface of the boiler, or if this is kept at the same size, there may be an increase in power or a reduction in the work imposed upon the steam generator. In France the economy in fuel has been found of importance, even upon the Northern Railroad, the French line which obtains its coal at the lowest price.

Other objections made to the compound are noted, but they are really only a repetition of those which have

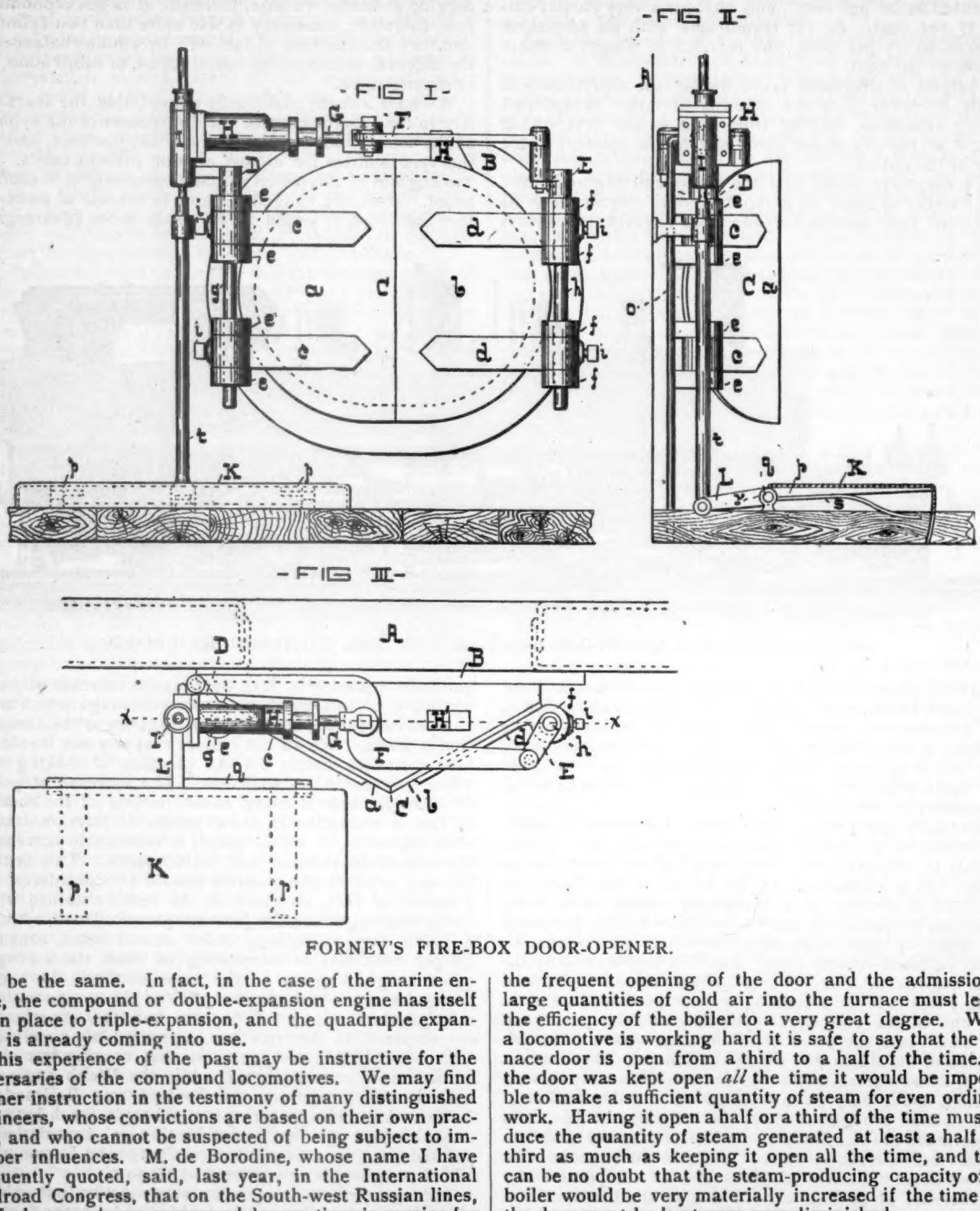
already been considered under different forms, and to repeat the arguments by which they are refuted seems hardly necessary here in this memoir, which has already extended itself to considerable length. In a word, it may be said that the compound locomotive is passing through the stage of argument and debate, beyond which the compound for stationary and marine work has already gone, and it is to be hoped that the result with the locomotive will be the same. In fact, in the case of the marine engine, the compound or double-expansion engine has itself given place to triple-expansion, and the quadruple expansion is already coming into use.

This experience of the past may be instructive for the adversaries of the compound locomotives. We may find further instruction in the testimony of many distinguished engineers, whose convictions are based on their own practice, and who cannot be suspected of being subject to improper influences. M. de Borodine, whose name I have frequently quoted, said, last year, in the International Railroad Congress, that on the South-west Russian lines, "We have a dozen compound locomotives in service for several years, and they have given such satisfactory results that all those which we build in the future will be of this system. I believe that the next Exposition in Paris will show more compound engines, and that no company will exhibit any ordinary locomotive."

Is not such a clear declaration, based on prolonged personal experience, worth more than volumes of argument? We could add nothing to it which would not weaken it.

FIRE-BOX DOOR-OPENER.

THE inconvenience of opening and closing the doors of locomotive fire-boxes every time a shovelful of coal must be put on the grate every fireman knows, and all persons who understand the principles of combustion and have had opportunities of observing must be convinced that the frequent opening of the door and the admission of large quantities of cold air into the furnace must lessen the efficiency of the boiler to a very great degree. When a locomotive is working hard it is safe to say that the furnace door is open from a third to a half of the time. If the door was kept open *all* the time it would be impossible to make a sufficient quantity of steam for even ordinary work. Having it open a half or a third of the time must reduce the quantity of steam generated at least a half or a third as much as keeping it open all the time, and there can be no doubt that the steam-producing capacity of the boiler would be very materially increased if the time that the door must be kept open was diminished.



FORNEY'S FIRE-BOX DOOR-OPENER.

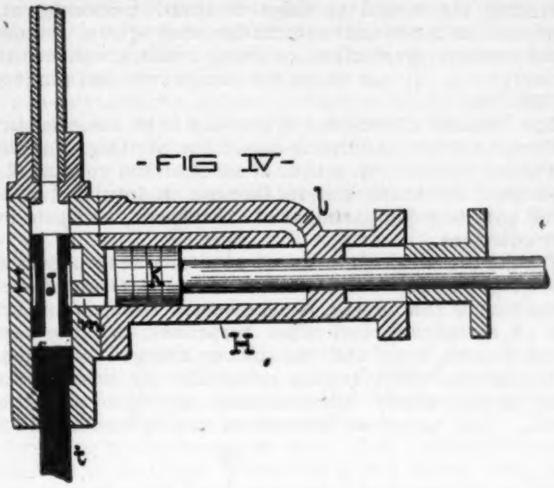
The invention illustrated herewith is intended to facilitate the opening and closing of the door, do it quicker, and with more ease and less inconvenience to the fireman, so that it will be open for much shorter periods, and thus admit smaller quantities of cold air to the fire-box.

Figs. I and II are, respectively, a front and a side view of a locomotive-furnace door provided with the improvements. Fig. III is a plan of fig. I, showing a part of the front of the boiler. Figs. IV and V are respectively a vertical sec-

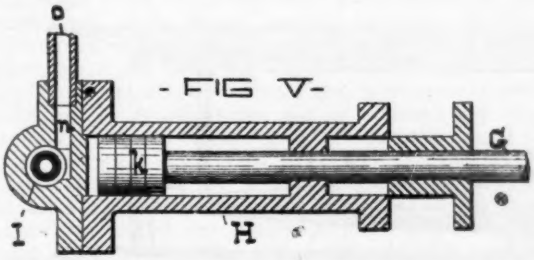
tion and a sectional plan of certain parts of the invention on an enlarged scale.

In the drawings *A* is a part of the boiler, and *B* the door-frame secured to the boiler in the usual manner.

a and *b* are the furnace-doors, formed in two parts or sections, which are hinged to the frame *B*. The hinges consist of the brackets *c* and *d*, attached, respectively, to the sections *a* and *b* of the door, the lugs *e* and *f*, attached to the frame *B*, and the bolts *g* and *h*. These bolts pass



- FIG IV -



- FIG V -

loosely through the lugs *e* and *f*, and are fastened to the brackets, preferably, by means of set-screws *i*.

D and *E* are arms or cranks rigidly attached to the upper ends of the bolts *g* and *h*, and they project in opposite directions from a dotted line, *x x*, in fig. III—which extends through the center of the bolts *g* and *h*—in order that when the cranks are moved in the same direction the bolts *g* and *h* are swung around in opposite directions, and the sections *a* and *b* of the door *C* are jointly opened or closed. The arms *D* and *E* are coupled together by means of an offset-bar, *F*, to the middle of which is pivoted the piston-rod *G* of a steam-cylinder, *H*, hereinafter described.

As the ends of the coupling-bar *F* move in arcs of circles curved in opposite directions, the path of the middle point of the bar is a straight line, and with the cranks forms a "parallel motion," therefore the piston-rod *G* can be connected directly to the bar at this point without the intervention of guides or connecting-rods to maintain the rectilineal movement of the end of the rod.

H' is a stop to arrest the movement of the piston when the doors are opened wide enough. The cylinder is supported in any suitable manner, but preferably from the front of the boiler, and it is provided with a piston, *k*, figs. IV and V, which is at the inner end of the piston-rod *G*.

I is the steam-valve chest at the rear end of the cylinder *H*, connected with the interior of the said cylinder by means of the front and rear steam-ports, *l* and *m*. The exhaust-port is denoted by *n*, and the exhaust-pipe leading therefrom by *o*.

J is the steam-valve, which is shown as of the piston form, adapted to slide within the valve-chest *I*. This valve operates to control the admission of steam to the cylinder in substantially the same manner as that of a slide-valve engine, and it is moved from a hinged foot-plate, *K*, figs. I–III, by mechanism substantially as follows: The foot-plate is secured to two arms, *p p*, on a vibratory shaft, *q*, supported in bearings *r* on the foot-board and yieldingly supported by means of a spring, *s*, underneath. *L* is a third arm, also attached to the shaft *q*, which projects in an opposite direction to the ones *p*. To the arm *L* is connected a rod, *t*, the upper end of which is just below the bottom of the valve-chest. The valve has a projection which extends downward and outside of the valve-chest, as shown at *t*, fig. IV, and bears on the upper end of the rod *t*.

When the fireman desires to open the furnace-door, he depresses the plate *K* with his foot, when the steam-valve *I* is raised through the medium of the arms *p p* and *L* and the rod *t*, before described, and steam is admitted to the port *m*, and thence to the rear end of the cylinder *H*. The piston is thus driven forward, and its movement transmitted to the two sections of the furnace-door through the medium of the piston-rod *G*, offset-rod *F*, arms *D* and *E*, and the bolts *g* and *h*, to which the said arms are rigidly attached. In the depression of the foot-plate the supporting spring [*s* is forced down ;] consequently its resilient action as the foot is removed raises the plate *K* and arms *p p* and depresses the end of the arm *L* and rod *t*. The pressure of the steam above the valve then forces it down into the position shown in fig. IV, which permits the steam below the piston to be exhausted and live steam to enter the cylinder in front, which forces the piston back into the position shown in fig. IV, thus closing the doors.

This device is the invention and has been patented by Mr. M. N. Forney, whose address is at the office of the Railroad and Engineering Journal, No. 47 Cedar Street, New York.

THE SUBMARINE MINE AND TORPEDO IN HARBOR DEFENSE.

By First Lieutenant Joseph M. Califf, Third U. S. Artillery.

(*Concluded from page 219.*)

XIV.—CONTROLLABLE TORPEDOES.

These, being always under control and intended to be operated from shore stations, are particularly well adapted for harbor defense. This class embraces the *spar*, the *towing*, as well as all the controllable locomotive torpedoes. The latter, and by far the most important type, includes all those operated by power developed at some point exterior to themselves, which power is transmitted to the torpedo either by electrical or mechanical means, or where the motive power is self-contained and the control alone exercised from the shore. The *Sims-Edison*, the *Patrick*, the *Brennan*, and the *Victoria* are the best-known examples of locomotive torpedoes.

Spar torpedoes. As the pioneer of all offensive devices of its kind, the spar torpedo has a record for actual work unequalled by any other similar weapon. As an English writer says (Sleeman), "all the ships that have so far been sunk or injured by torpedoes have met their fate at the hands of the spar torpedo, with the exception of one extremely doubtful case of a vessel sunk by a Whitehead in the Russo-Turkish war of 1877." It should be said, however, that none of the locomotive type have as yet had an opportunity to test their efficiency in actual warfare.

In the many new devices being brought forward, its value is likely to be lost sight of. Its extremely limited range, which is the length of the spar to which it is attached, is in a measure compensated for by the accuracy and certainty with which its blow can be delivered. As a weapon it requires no detailed description. From the simple case of explosive fastened to the end of a spar, which explodes upon contact with the side of an enemy's ship, to some of the later and more elaborate inventions, the principle is the same. Although its employment is always considered more than usually hazardous, yet as the

equipment of small, swift steam-launches and in the hands of a daring commander, ready to take advantage of smoke or fog or accident to swoop down upon an incautious adversary, it is believed to have a field to itself in the problem of harbor defense.

The *Towing torpedo*, whose name indicates its mode of action, was at one time largely experimented with and adopted to some extent in the French and other services, but with the introduction of improved forms of controllable torpedoes it has generally been discarded.

Locomotive torpedoes. The *Sims-Edison* torpedo is an American invention, propelled, controlled and exploded by means of an electrical current supplied through proper cables from a dynamo on shore. Fig. 24 represents the general features of this weapon. It consists of two parts—the torpedo proper and a float, which maintains it at a uniform depth. The former is a copper cylinder with conical ends, 20 ft. x 30 in., rigidly connected with its float, of the same material, by steel rods. The forward rod slants to the rear and upward from the nose of the torpedo, so that it will dive under any ordinary obstruction in its path. Projecting above the float are two steel rods, each carrying a ball for purposes of steering. These rods are hinged to the skin of the float, and bend backward when an obstruction is encountered and the torpedo dives, resuming their upright position when the obstruction is passed. The float is boat-shaped, is water-tight, and filled with cotton or other buoyant material. The torpedo body is divided into four sections, as shown. The front compartment, *a*, is for the explosive charge. Within the second, *b*, is coiled a compound cable, having a small insulated core in the center for the steering current, and an annular conductor for the motor current. The third compartment, *c*, contains an Edison motor, which can, at full speed, develop something over 30 H.P. of energy for propulsion. The after compartment, *d*, contains the steering gear. The direction is given through the agency of an electro-magnet and a polarized relay, actuated by the steering current through the central conductor of the cable. By these means the balanced rudder on top of the after cone can be thrown to one side or the other at will. It has a total weight of about 4,000 lbs.

Fig. 24

The range of this torpedo is limited only by the length of cable that can be carried and the distance the steering balls can be seen. Two sizes have been proposed, carrying cable for one and two miles. A charge of from 200 to 500 lbs. of high explosive, according to the size, is provided. This is exploded electrically at the will of the operator. This torpedo has been carefully experimented with at the Willett's Point Torpedo School, and has been found to be under thorough control. A speed of 22 miles per hour has been obtained.

The *Patrick* torpedo resembles the Sims-Edison just described in that it consists of a torpedo proper and a float, which maintains it at a submergence of about 3 ft. It is driven by a carbonic acid gas engine, and has attained a speed of about 20 miles per hour, and has a range of one mile. The charge is 200 lbs. of dynamite, which may be fired electrically at will or upon contact. It is started, stopped and guided upon its course by means of a two-wire electric cable, in connection with 100 cells bichromate battery. The wire is paid out from the shore station as the torpedo advances. It has received a favorable report from a board of naval officers, after an extended series of experiments.

The *Brennan* torpedo has been adopted in England. In it the motive power is external to the weapon, and is communicated mechanically to the torpedo. Upon two reels within the torpedo, which are geared to the propeller-shafts, is wound a quantity of fine steel wire equal in length to four times the distance to be run. The ends of these wires are led out through the top of the shell, through leaders at the tail and thence over drums at the winding station on shore. By winding up the wires on the drums the reels are made to revolve, and thus actuate the propeller. By operating the drums at different speed motion is communicated to the rudder and the direction given. Hydrostatic pressure, transmitted to diving rudders, controls the submergence. It has about the same speed and range as the Patrick.

The *Victoria* torpedo is a Whitehead in all essential particulars, with the additional device for starting, stopping and firing it at will by means of an electrical current supplied from the shore station through an insulated cable coiled within a compartment of the torpedo, and paid out as it advances.

For the practical operation of controllable torpedoes an observing station, where a clear and uninterrupted view of the harbor can be had, is necessary. Here, in any system of electrically controlled torpedoes, are the keys, switch-boards, etc., and the officer charged with their manipulation. This station must rely for safety either upon being wholly inconspicuous or upon protective works. The torpedoes themselves can be moored in any concealed position, while the dynamo, engine, etc., must, of course, be perfectly protected by bomb-proofs, or otherwise.

Many other types of both classes of torpedoes, other than those mentioned, have been experimented with with greater or less success; these latter, however, are considered the most promising. Abroad, the Whitehead type has been universally adopted, and is being manufactured in large numbers both in England and upon the Continent. Of the controllable class, the English have purchased the Brennan, and have already begun its manufacture and distribution. The French have experimented with the Patrick, but other than these, it is not known that any other power contemplates the introduction of controllable torpedoes. On this side of the Atlantic contract has been made for a considerable number of Howell torpedoes, but it is not known that any have been delivered, nor have we a single controllable torpedo other than one or two purchased for experiment.

The chief drawback to any fish or missile torpedo must always be a want of accuracy. Traversing a medium that is never wholly at rest; influenced, even when its initial direction is true, by waves, tides and currents; often launched upon its course from a moving against another moving object, it can easily be seen how uncertain are likely to be the results obtained. The controllable torpedo, on the other hand, can be driven against its object, when atmospheric conditions are favorable, with great accuracy, carrying at the same time considerably greater charges of explosive. It should not be forgotten, however, that while a Whitehead or a Howell costs about $2,000 each, a Sims-Edison or a Patrick will cost just about ten times this amount; nor that a more or less complicated shore plant is needed for the service of the latter, while the former can be discharged without preparation of any kind.

XV.—GENERAL CONSIDERATIONS.

Whatever may be the character of the mine and torpedo defense of a harbor, it must not be forgotten that, no matter how elaborate and efficient these may be, they are only auxiliary. The main reliance must always be upon batteries and guns, nor will the presence of these auxiliaries justify any material reduction in the artillery armament. In the absence of batteries any arrangement of mines can be readily neutralized or destroyed ; nor would it be possible to operate, against an enemy's fleet, any system of torpedoes—whether with launches, torpedo-boats or controllable torpedoes, except under the fire and protection of powerful batteries.

In none except the largest harbors would a resort be had to a complete mine and torpedo defense. In such a case this defense would have to be divided between the army and the navy contingent. In addition to the gun defense, all fixed mines and controllable torpedoes would naturally come under the control of the military commander ; while the use of harbor defense craft of all kinds, torpedo-boats and launches fall into the hands of the naval commander. The character of the harbor will determine the extent to which mines and torpedoes can be effectively employed. The water approaches of New York, for instance, lend themselves readily to an elaborate scheme of mine defense, while in the harbor of San Francisco the depth of water and the swiftness of the currents makes their employment extremely difficult, if not impracticable.

Speaking of the defense of New York, Colonel Bucknell says that it is a case where there is a strong front door but a weak back entrance—the back entrance being through Long Island Sound, and the front door by way of the Narrows. The eastern entrance to the Sound is through the Race, between Gardiner's and Gull Island, which is some 4½ miles in width, and is at present wholly unprotected by fortifications, and is a water-way where mines could not well be employed. Where the Sound narrows at Throgg's Neck (Fort Schuyler) both the artillery and mine defense become powerful. It is, however, only eight miles from upper New York, and vessels lying in this neighborhood could reach this point and the outlying suburbs of Brooklyn. To the south, with the proposed works on Coney Island, Sandy Hook and the Dry Romer Shoal finished, and supplemented by a system of mines, it is safe to say no hostile ship could enter the lower bay. With only 28½ ft. of water at high tide over the bar, entrance is forbidden to the largest foreign war-ships, but unless the defense can keep such vessels at a distance it would be quite possible for them to anchor in 30 ft. of water within eight miles of the Navy Yard and lower New York without crossing the bar, and reach those points with their projectiles.

Of the other cities on the coast, it may be said that at Portland 30 ft. can be carried to within half a mile of the wharves ; Boston, 30 ft. to within five miles of the State House ; Newport can be shelled from almost any position outside ; 30 ft. can be carried to within 2½ miles of New London ; any draft into Hampton Roads ; at Charleston 14 and Port Royal 21 ft. over the bar ; the largest vessels can approach Key West ; 19½ ft. can be carried over the outer bar at Mobile, and 26 ft. through the Southwest Pass of the Mississippi. On the Pacific coast, San Francisco, Seattle and Port Townsend can all be approached by the heaviest iron-clads.

It will take a war between great maritime powers to determine the true value of torpedoes and mines in harbor defense. As has already been said, it is believed that too much is expected of these weapons. The lessons taught by our Civil War are misleading in that, in looking over the long list of vessels damaged or destroyed by their agency, it is apt to be forgotten that these were hastily built, single-bottomed, and, one may suppose, structurally weak specimens of naval construction, or were improvised from second-hand material. The double-bottomed, cellular compartment steel war-ship of to-day would have little to fear from the gunpowder torpedoes of the Confederates. Not only this, but the experiments made abroad with high explosives, notably those known as the *Oberon* and *Resistance* experiments, supplemented by others made in Italy and France, clearly indicate that very considerable charges of high explosives may be detonated near or against the bottom of a modern war-ship without putting it out of action.

When it is remembered that a single shell exploded in the shore "plant" of a system of controllable mines or torpedoes would probably put the whole system out of action, or that the breaking of a single electrical cable might accomplish the same thing, to say nothing of the nets, booms, etc., that would be used to neutralize the action of movable torpedoes, or the difficulty of operating this class of weapons in a harbor filled with floating ice, one is fully justified in the belief that if the main defense of harbor or water-way is ever left to mines and torpedoes, instead of to guns and batteries, the hour of need will demonstrate that reliance has been placed upon a broken reed.

WATER-POWERS AND ELECTRICAL TRANSMISSION.

(From the *Electrical Engineer*.)

VARIOUS articles in this issue bear upon the important question of the electrical utilization of water power. The leading contribution on the subject is the admirable paper read before the Buffalo Electrical Society by Mr. Madison Buell, who has made a masterly compilation of the data of work in this line, and presents his results in a most attractive and instructive form. Another article is that descriptive of the work proposed at Lauffen, on the Neckar, in the transmission of 300 H.P. A third article deals with the installation for the extensive utilization of water-power electrically at Olympia, Wash., and a fourth gives some details of the work already begun at Joplin, Mo., where power and light are to be distributed over a wide area in a mining district.

It will be observed that Mr. Buell looks for the almost complete replacement of steam-engines by turbines through the use of electricity. While we share many of his opinions and much of his enthusiasm on the task that water-power has before it, we cannot go quite so far as he does. On the contrary, we believe that for an indefinite time to come the use of steam-engines will increase. The engines will grow in size and, by compounding and condensing methods, be made more and more economical of fuel or water. The great change that does lie before us is that, instead of having a large number of separate steam plants, we shall have central steam plants whose power will be cheaply and effectively distributed through the agency of electricity. This process has already begun, and the extension of motor service has the beneficial effect also of making the production of current for lighting cheaper too.

In a word, the rapid increase in water-power plants will not greatly affect, or be affected by, the existence of steam plants. Any change that comes will not be in the direction of abolishing a single agency we now enjoy, but rather by way of limiting each to the work for which it possesses undeniable advantages of economy, efficiency and availability. Moreover, while the water-powers still to be brought under the yoke represent an enormous total waste, the net power utilizable will be but a fraction of the sum. Thus Niagara takes the drainage of an area of nearly 250,000 square miles, but it is only a small part of Niagara that even the most sanguine engineer expects to put in harness.

It seems well to make these remarks in passing, as it is often said by way of criticism that electrical engineers in dealing with these questions are too fond of looking upon all the possibilities as actual achievements, and very slow to admit the existence of any insurmountable difficulties. If this be a fault, it is at least a pardonable one, and certainly Mr. Buell has made a magnificent showing of hard, honest and successful work in this field, not only in America, but in Europe and other parts of the world.

As demonstrating the advanced state of the art of the electric transmission of water-power as compared with its condition less than 10 years ago, we need only refer again to the experiments which have just concluded, and which constitute the preliminary tests of the transmission plant

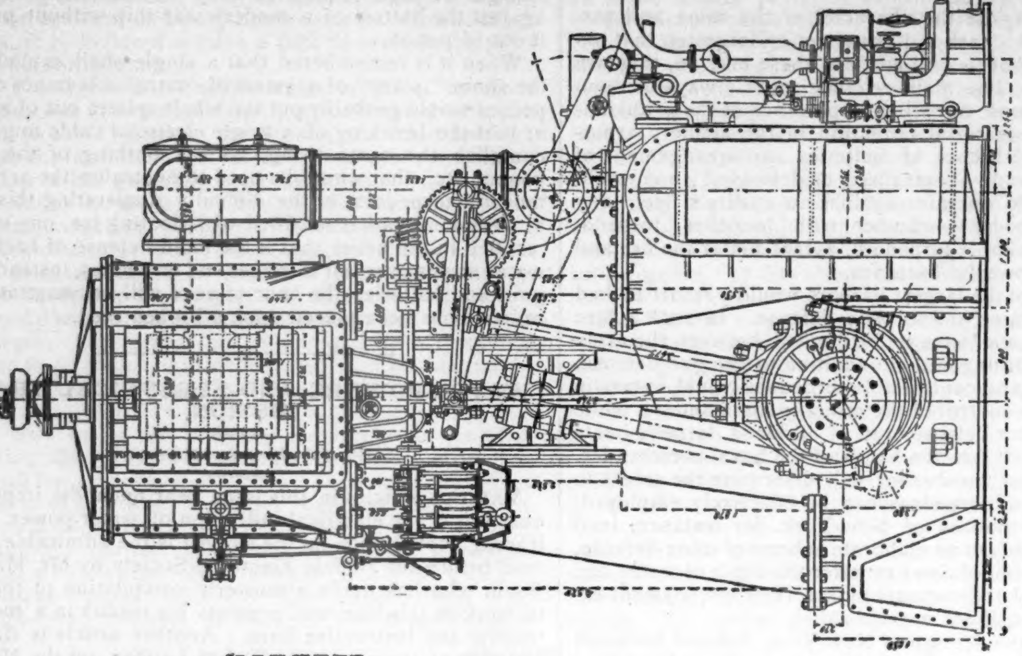


Fig. 4.

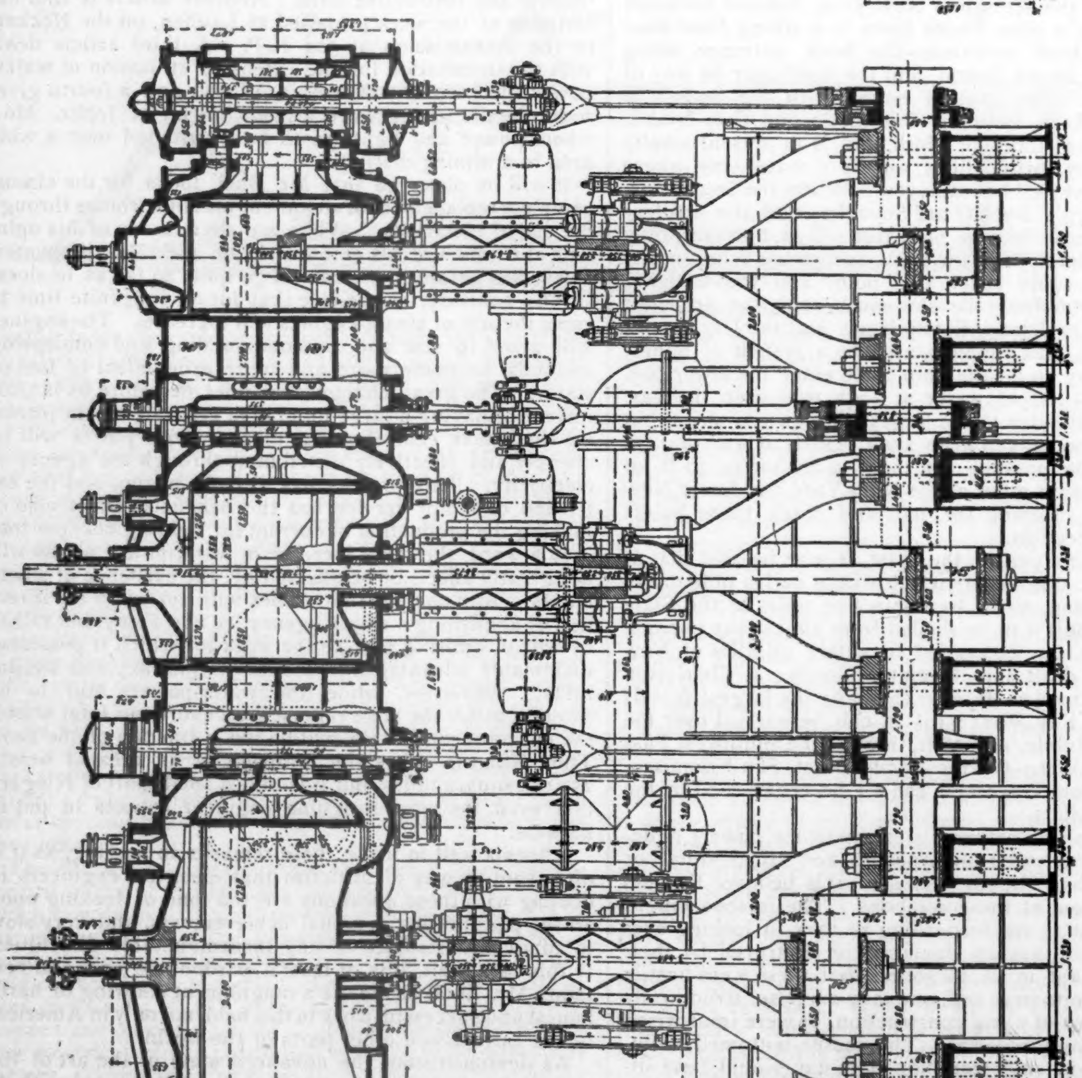
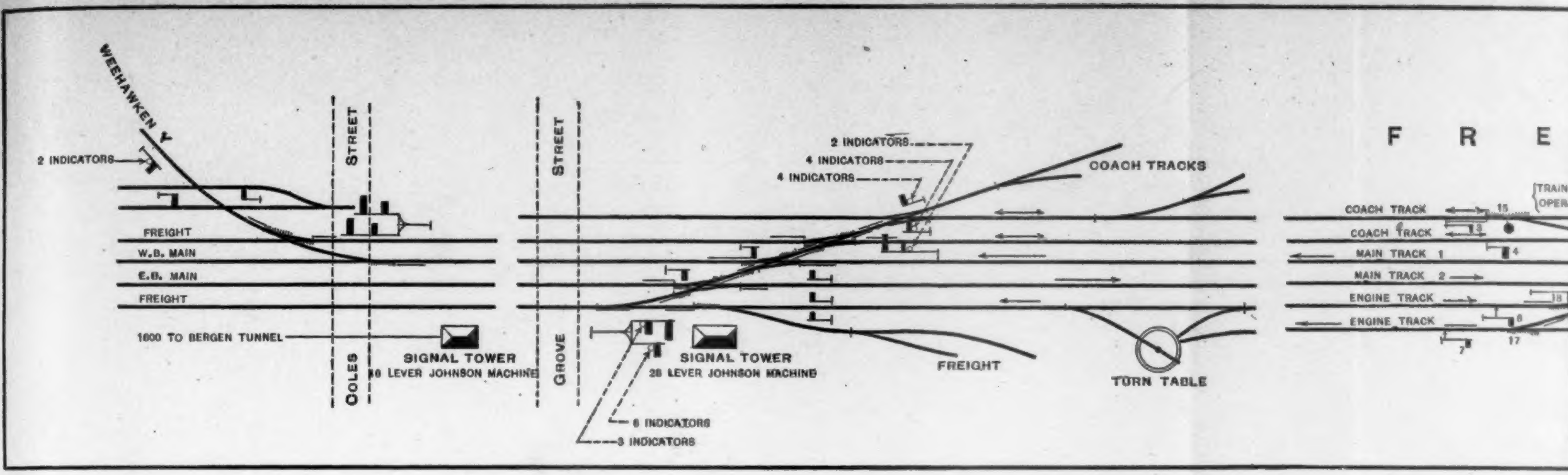


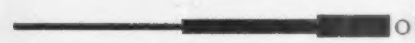
Fig. 1.

TRIPLE-EXPANSION ENGINES FOR ITALIAN STEAMER "SIRIO"



NEW INTERLOCKING AT THE JERSEY CITY TERMINAL PASSENGER S

CONSTRUCTED BY THE JOHNSON RAILRO

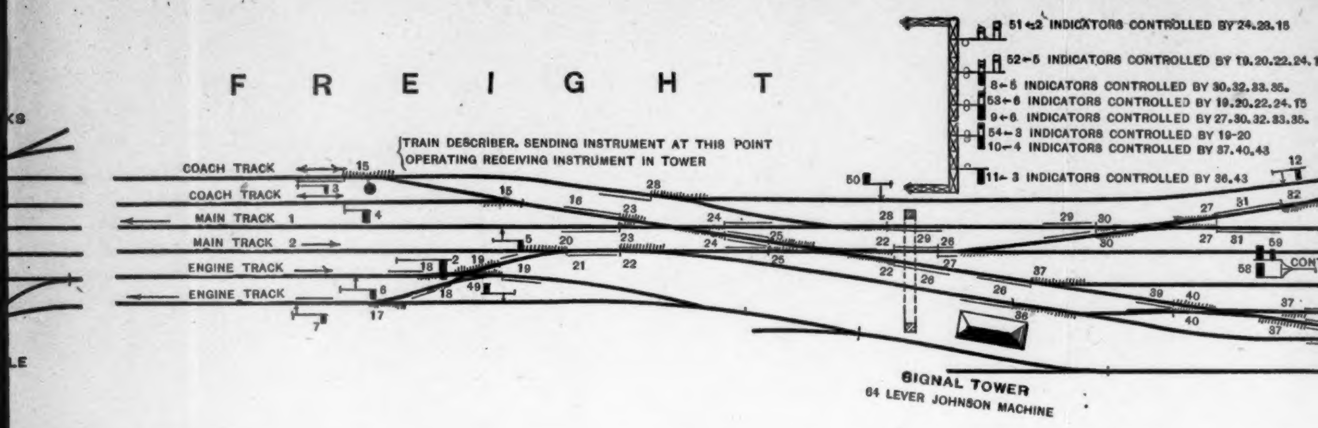


THE NEW INTERLOCKING AT THE

THE accompanying plan shows the new interlocking, recently constructed by the Johnson Railroad Signal Company, of Rahway, N. J., in connection with the Jersey City terminus of the New York, Lake Erie & Western Railroad. There are three towers—Coles Street, Grove Street, and the terminus. It is the intention of the Erie Company to make use of the new towers, in extending the Sykes block system to the terminus, by three additional block sections, substituting this system for the automatic banjo signals at present in use.

The terminus tower was brought into service on Sunday, May 3, at 10 A.M. Owing to the great number of train movements made between the hours of 8 A. M. and 10 A.M., and from 5 P.M. to 7 P.M., the levermen were given three weeks' instruction and practice, and three practice Sundays, working the traffic. There are three shifts of levermen, the two day shifts being each composed of three levermen and one foreman, and the night shift of two levermen and one foreman. All the men were taken from the yard, and had had no previous experience with interlocking. The foreman has a seat in the bay-window, and his duty is to attend to the various audible and visual notices given on the "train describers," which connect with the Train Starter, the Yard Master, the Engine Despatcher, and Bergen West Tower. He acknowledges each notice by two beats of the bell. The train describers give him timely warning of the nature of the trains or engines moving or about to move either East or West. Each train describer is capable of 14 indications, all of which are transmitted by two lines and one battery. Grove Street has also one train describer, operated by Bergen West, for trains coming East. All important points are also connected by telephone, for use in cases of emergency. The train describers, telephones and bells are all conveniently located in the bay-window of the tower.

The Foreman has control of all train movements, and the levermen work in accordance with his verbal instructions. This arrangement was c
to the excessive congestion of t
day. There are eight tracks in
parture of passenger trains fro
by starting signals mounted on
posts at the rear of the shed.
from a tower placed immediat
munication with the Station-ma
of the last boats which are s
particular train, from the up-t
the boat slips are deposited in
where they are signed and sen
by means of a small tube. On
fies the main signal tower,
train is ready to depart from
the acknowledgment is receiv
small arm at the end of the t
position, which informs the tr
must depart. At the same ti



SEY CITY TERMINAL PASSENGER STATION OF THE NEW YORK, LAKE ERIE & WESTERN RAILROAD.

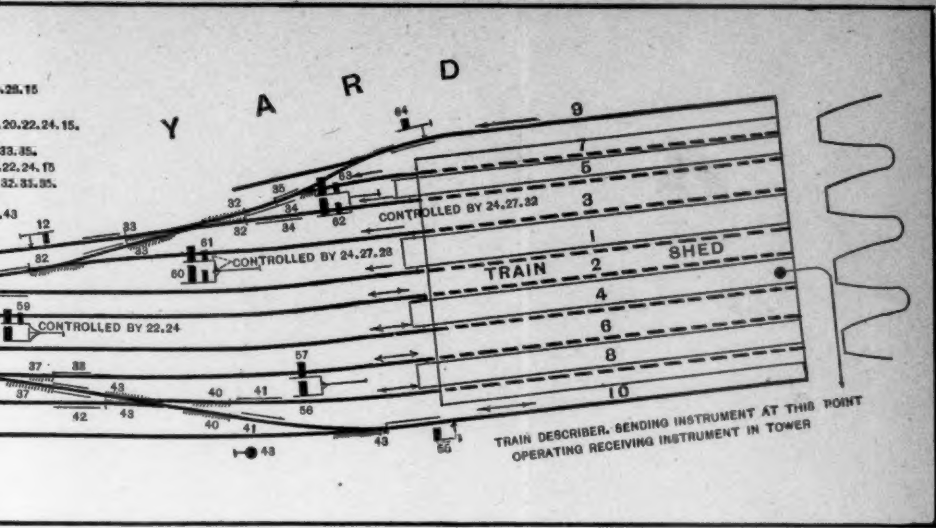
ONSTRUCTED BY THE JOHNSON RAILROAD SIGNAL COMPANY, RAHWAY, N. J.

NEW INTERLOCKING AT THE ERIE TERMINUS IN JERSEY CITY.

tions. This arrangement was considered advisable, owing to the excessive congestion of traffic at certain times in the day. There are eight tracks in the train-shed, and the departure of passenger trains from these tracks is governed by starting signals mounted on continuations of the gate-posts at the rear of the shed. These signals are operated from a tower placed immediately above, and in easy communication with the Station-master's office. On the arrival of the last boats which are scheduled to connect with a particular train, from the up-town and down-town ferries, the boat slips are deposited in the Station-master's office, where they are signed and sent up to the signalman above, by means of a small tube. On receipt of the slips, he notifies the main signal tower, by a train describer, that a train is ready to depart from a certain track. As soon as the acknowledgment is received from the main tower, the small arm at the end of the track is lowered to the clear position, which informs the train conductor that his train must depart. At the same time the gate is closed.

The only unique signalling is that on the s
The bridge is so placed that the signals th
movements from any track to any track, goin
or West. By the use of selectors, all the b
are operated by eight levers. Without select
signals would have required 36 levers. All t
are those of the Johnson Railroad Signal C
noticeable feature was the absence of troubl
catching of locking. This trouble is very
bringing into use a Saxby & Farmer mach
sponding size.

On the first day of opening—Sunday, May
no delay whatever; but when the rush cam
morning, the men became somewhat confus
layed a few trains. They caught up with t
by 12 o'clock noon. The same thing occ
afternoon shift, but these men also caugh
time-table by 7 P.M. On Tuesday morning
remarkable improvement in the speed with wh



.

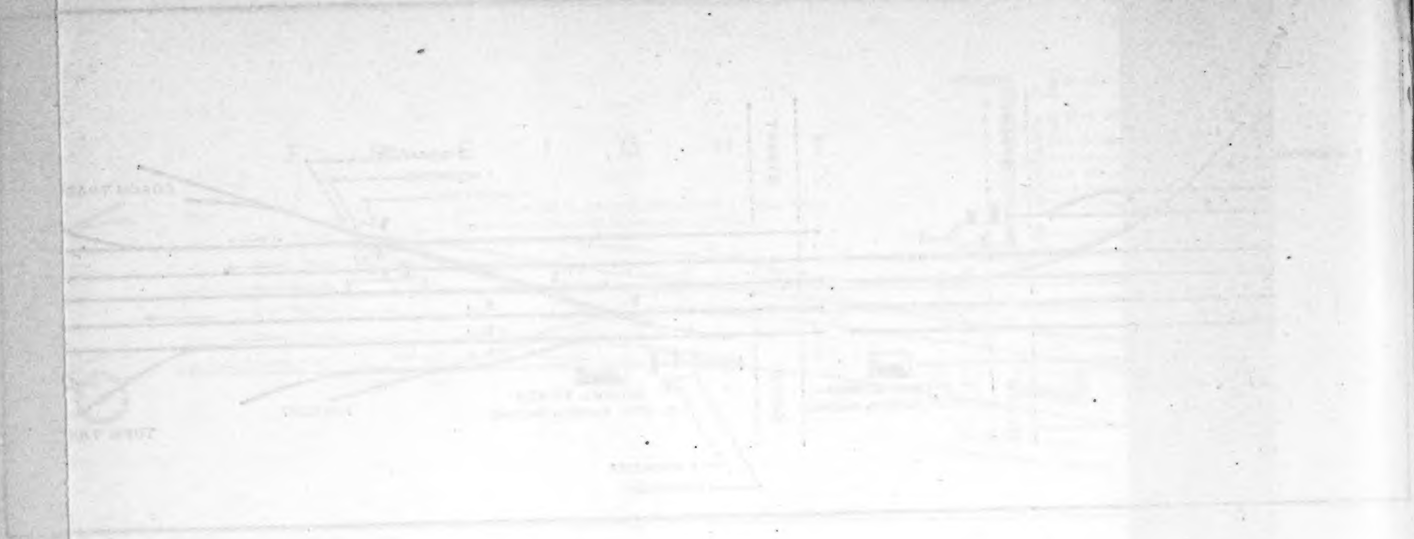
n the signal bridge.
nals thereon govern
k, going either East
the bridge signals
selectors the bridge
All the appliances
ignal Company. A
trouble through the
very noticeable in
machine of corre-

, May 3—there was
h came on Monday
confused, and so de-
with the time-table
g occurred with the
caught up with the
orning there was a
with which the trains

were handled, and no delay whatever took place. About 2 P.M. an accident occurred in the Bergen Tunnel, which completely stopped traffic both ways for three hours. There was naturally a rush when the tunnel was cleared, and Superintendent Stearns says that the shed was cleared in quicker time than had ever been the case before with the hand switches. Since then there has been a gradual improvement, so that the Erie Company expects presently to find plenty of room in what was formerly a cramped train-shed.

Mr. C. W. Buckholz, Chief Engineer of the New York, Lake Erie & Western Railroad, has had charge of the concentration and rearrangement of the switches, and also of the interlocking. Mr. Charles R. Johnson and Messrs. Henry and Arthur H. Johnson are the contractors' engineers.

The frogs and switches were supplied by the Pennsylvania Steel Company.



to be installed in connection with the Frankfort electrical exhibition to be held this year. It will be recalled that in 1882, Marcel Deprez carried out his famous experiment of transmitting the power of a waterfall at Miesbach to Munich, a distance of 37 miles. In that experiment, which is justly looked upon as the one which finally settled the question of the practicability of long distance power transmission, the potentials employed barely exceeded 1,800 volts, while the actual power obtained from the motor at the distant end did not exceed ½ H. P. We recall distinctly the objections raised at that time to the success of the system of transmission, among them being that of the inability of the armature to withstand successfully pressures exceeding very much the one employed. At that time, however, the alternating current had scarcely been hinted at, much less put in actual practice. To-day, however, the converter and alternating machine allow us to use potentials 20 times as great as that deemed safe only 10 years ago, by confining such high potentials to the outside circuits, and employing in the machine at the station the low tension current of conversion. Instead of ½ H. P. transmitted for 37 miles, it is contemplated to transmit 300 H. P. over 115 miles, and over a wire ⅙ in. in diameter, and at a potential of 30,000 volts. With these new methods at our command, the problem of economic transmission of water-powers takes on an entirely new complexion, and where once the cost of conductors acted as a deterrent to the undertaking of such work, the present methods relegate their consideration to an inferior position. The success of the proposed plant at Frankfort would, we are certain, open up a new era in electric power transmission for long distances, and at last lead to the realization of the predictions made 10 years ago, that not only Niagara but every other available water-power would be utilized through the medium of electricity.

A TRIPLE-EXPANSION MARINE ENGINE.

(From the *Steamship*)

THE Italian General Navigation Company recently decided to change the engines of its large steamers *Sirio*, *Orione* and *Persio*, employed on the line between Italian ports and the Argentine Republic, with a view to increasing their speed. The former engines, although triple-expansion and of modern make, did not develop a power corresponding to their weight, so that the boats could not attain the desired speed. The construction of the new engines was entrusted to the works of G. Ansaldo & Company, of Sampierdarena, who are favorably known through many engines furnished for the Italian Navy, and possess excellent plant for work of this character. The new engines were to be triple-expansion, developing with a boiler pressure of 160 lbs. 5,000 indicated H. P. The efforts of the engineers of the firm were directed toward producing an engine of the greatest simplicity and perfection in all its parts, so that the result represented by our illustrations may be regarded as the best specimen of Italian marine engineering of the present time.

The engines are of the usual type for mercantile steamers, with three inverted cylinders, the diameters being 0.94 m. (37 in.) for the high-pressure, 1.55 m. (61 in.) for the intermediate, and 2.50 m. (98.5 in.) for the low-pressure cylinder, the stroke of the pistons being 1.52 m. (60 in.) for all of them. The valves are worked by a

Fig. 2.

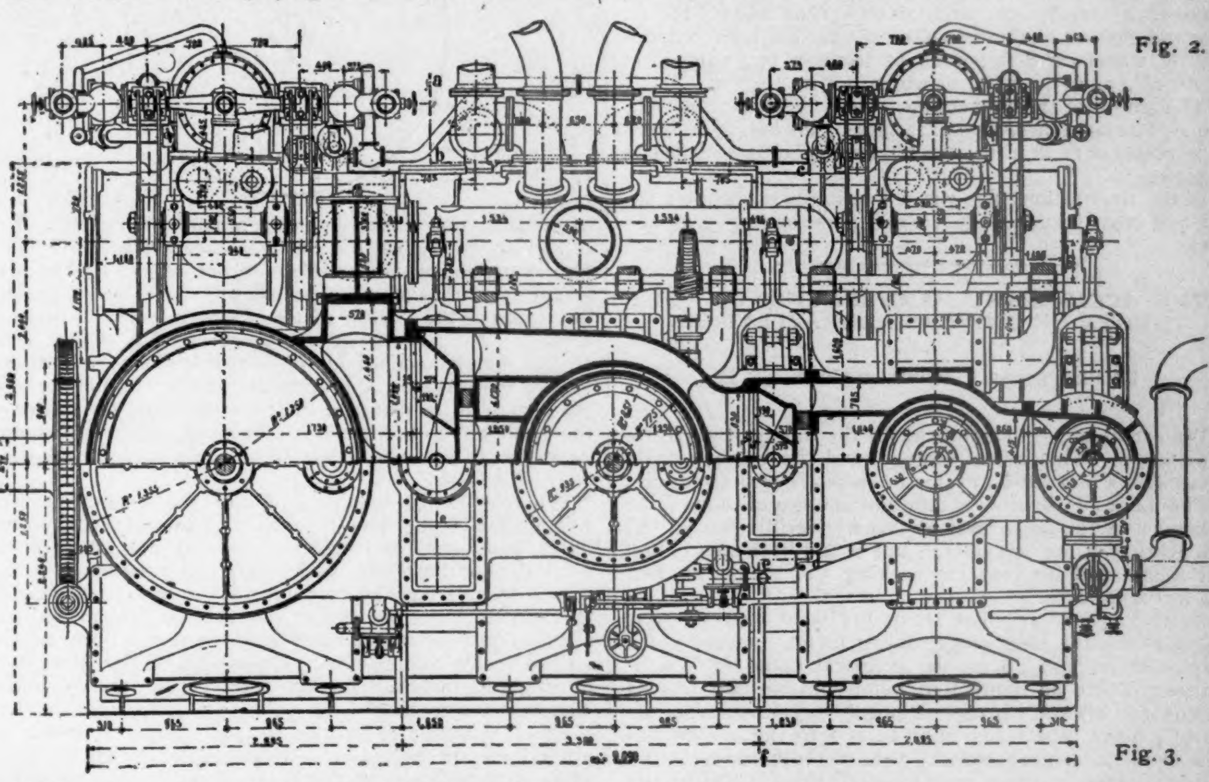


Fig. 3.

Stephenson link motion with open rods. The reversal of the engines is obtained by means of a small auxiliary engine with two coupled cylinders, which turn the reversing shaft by means of a worm or worm-wheel, and acts promptly and regularly. The condenser is placed longitudinally alongside the three engines, and is made in two parts that may be disconnected, so as to use one only while the other is being repaired. To the condenser two air-pumps and the usual feed and bilge-pumps are attached. The water circulation through the condenser is effected by means of two centrifugal pumps, with separate engines. For feeding the boilers several pumps on Weir's system, with independent motors, an auxiliary pump and air-pump, steering motors, etc., are provided. All parts are easily accessible, and the principal handles within reach of the engineer on a platform as usual. Steam is supplied by four large double-ended boilers with six furnaces each made of steel plates, with Purves furnaces. The total heating surface amounts to about 1,300 sq. m. (14,000 sq. ft.). Two funnels carry off the combustion products.

At the trial the engines were found to be easy to handle and to work regularly, with a good distribution of the stresses. Several trial trips were made in the Gulf of Genoa, both in quiet and rough weather, and these were very satisfactory as regards the working of all parts and facility of steering. Numerous diagrams were taken at

a speed of 75 revolutions, which was the maximum obtained, as well as at 70 and 68 revolutions, which proved that the power demanded from the engines with 70 revolutions was fully obtained ; and that it was not difficult to obtain 6,000 H. P. with 74 or 75 revolutions, 6,116 H. P. having been indicated on a run of 11¼ miles. During the last trial of 6 hours 12 minutes, in which the average contracted power of 5,000 H. P. was maintained, the consumption of fuel amounted to 20.303 metric tons, or 1.43 lbs. per indicated H. P. per hour, which is a very satisfactory result, if we take into consideration that generally marine engines work most economically at a less power than the indicated power contracted for.

The crank-shaft is fitted with powerful double worm and worm-wheel gearing, shown at the left side of the illustrations, for which we are indebted to *L'Industria*. This serves to turn the crank-shaft slowly around for setting the valves and making other adjustments, and is no doubt a useful adjunct to engines of such large size as those described. The dimensions of the gearing are : Pitch diameter of large worm-wheel, 7 ft. 2 in.; pitch of teeth, 3 in.; number of teeth, 90 ; pitch diameter of worm, 12½ in. The dimensions of the first-motion gear are : Pitch diameter of wheel, 17.8 in.; pitch of teeth, 2 in.; number of teeth, 28 ; pitch diameter of worm, 4.8 in.

The length of the connecting-rods of the engine is 11 ft. 2 in. The condenser has 4,222 tubes ; the length between tube-plates is 11 ft. 4 in.; the total refrigerating surface is 9,345 sq. ft.

In the illustrations fig. 1 is a longitudinal section ; fig. 2 a half cross-section ; fig. 3 a half plan, and fig. 4 an end view.

THE ACCIDENTAL VERIFICATION OF THE THEORY OF UNIVERSAL GRAVITATION.

By Professor J. Howard Gore, Ph.D.

We are indebted to a mistake for the theory of universal gravitation. This seems strange, and the curious chain of accidents that led up to this mistake are still stranger.

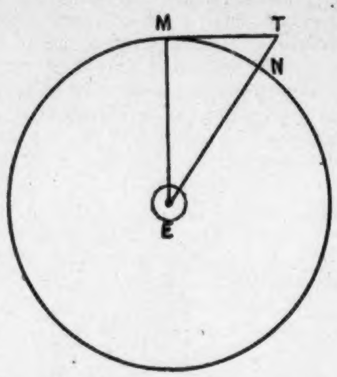
The name of Newton is familiar to all, and to many he is known as the discoverer of this wonderful theory. Its discovery was not accidental, but it had been sought and not found, and between the seeking and the finding laid the fortunate error.

At the age of 24—that is, in the year 1665—he was obliged to leave Cambridge, owing to the presence of a plague there, and go to his ancestral home at Woolsthorpe. There he found that quiet solitude that was so welcome to his student nature, and thus removed from the world's noisy bustle, his mind turned to the contemplation of physical phenomena. One of these was gravity ; and while trying to find some tangible clew to this mystic power of nature, it is said that he was aroused from his day-dream by the fall of an apple. Some assert that the apple struck him on the head, and so gave him an idea of the momentum acquired in falling. If he happened to be in a very brown study the blow would hardly suffice to awake him, if we may judge from the following anecdote :

Newton, when riding through the country, on one occasion came to a hill which he thought too steep for the horse to ascend with ease while encumbered with the rider, so he dismounted, and throwing the rein over his arm, he walked leisurely up the hill, leading the horse. Some interesting problem or idea took possession of his mind, causing him to be unconscious of his arrival at the top, nor did he think of mounting until fatigue suggested that riding was more agreeable than walking. He turned around to mount, but instead of finding his horse he found only the bridle, which he had been dragging.

Whether the apple hit him or not, whether it fell or not, it was while in the country that he began his speculations regarding gravity, reasoning that the force which draws downward a stone from the hand, an apple from the top of the highest tree, a drop of water from the loftiest cloud, might extend still further—drawing the moon to the earth, the earth toward the sun, with centrifugal force to keep all in place.

Thus a question was asked ; the problem stated challenged a solution. Nor was progress arrested until diagram and figures had exhausted their resources. Suppose E be the earth and $M N$ the orbit of the moon—that is, the path the moon follows in revolving around the earth. It was known before Newton's time that the distance from the earth to the moon was 60 times the radius of the former. If the moon moved in a straight line, as it naturally would if not acted upon by some other force, at the end of a given time—say one second—it should be at T; but it was known to be at N—that is, the moon had fallen in one second toward the earth through the distance $T N$. This Newton surmised was the effect of gravity, the amount



of the attraction exercised on the moon by the earth. The fall $T N$ was known, the distance through which a body on the surface of the earth falls in one second was known, and the fact that within certain limits the force of gravity decreases as the square of the distance increases was accepted. If this law of gravity was true, $T N$ should be to 16 feet the distance a body falls in one second on the surface of the earth, in a proportion which was inversely as the square of the distance of the moon from the center of the earth was to the radius of the earth. This proportion gave for $T N$ a value one-eighth less than observation showed it to be.

Where was the trouble ? Either the hypothesis was wrong or else the data incorrect. Every element of the latter had been confirmed by repeated observers except the radius of the earth, and surely this must be right, for it was taken from the computations of a Cambridge man (Wright). Therefore this hypothesis, so brilliant in conception, must be laid aside as insufficient in action, and the failure of this Achilles being known by all the great men of England, checked further research in this direction. This was the seeking.

About this time he became so much absorbed in the beginnings of the calculus and theories of light that he "laid aside all thoughts concerning the moon." Not being impatient to rush into print, but preferring to work quietly and for his own pleasure, he seldom prepared for publication, but stopped as soon as he could with his prophetic vision see results confirming or disproving hypotheses. Therefore Hooke, secretary of the Royal Society of London, wrote to him, asking him to contribute something to the *Philosophical Transactions*, the organ of the Society. In 1683 he complied with the request, sending a little dissertation to refute the popular belief that, since the earth moved from west to east, all falling bodies would be left to the east ; maintaining that they would be left to the westward, and that the path of the body would not be a straight line. He drew on the margin of his paper a line to show the kind of path which would be described, but then, thinking that the diagram would add nothing to his paper, he crossed it out by running his pen along this line in a wavy manner, as we now often do. Hooke, thinking the spiral line was meant for the real path and the other line for the path of popular belief, wrote in haste, saying, "You surely do not mean to say that the falling body has a *spiral* path ?" As is well known, Newton shrunk from controversies, even of the most friendly character ; he therefore decided to work over the entire problem and extend upward the point from which the body was supposed to drop. As he carried this point higher and higher, he naturally

thought of his investigations made 18 years before concerning the universality of gravitation. And simultaneously with this thought came the recollection that a new determination had been made of the size of the earth; perhaps he remembered that the former Secretary of the Royal Society had communicated to its members the results of this measurement. At all events, a search in the *Transactions*, published in 1675, disclosed a new value for the earth's radius found from arc measurements made by Picard.

Who was Picard? He was a priest more interested in mathematics than in religion, who was fortunate in being a friend of Mouton, a priest at Lyons, who was a friend of Riccioli, a priest at Bologna, who owned a book written by Snell. Thus we go, step by step, like in the "House that Jack Built," down to Snell, and the question comes, Who was he?

Snell was a Dutch mathematician who deserves our highest praise for conceiving and putting in successful operation the method now in use for determining the size of the earth by triangulation. His report was published in Leyden in 1617, and by some chance a copy of it reached the headquarters of the order of Jesuits at Bologna. It was seed falling in good ground, for it came into the hands of Riccioli, a member of that order. He was compiling a reformed geography, introducing the latest discoveries, and so revising old observations that the results might be free from incongruities, or at least be harmonious with one another. One of the elements on which no two agreed was the radius of the earth; but to Riccioli the method of Snell appeared by far the best; but before accepting it definitely he hoped some one else might test it.

Driven by the heat from Bologna, the Jesuit brethren repaired to their summer home on the mountain-side, and while there Riccioli, looking down upon the plains at their feet, saw a good place for a base line, and all around him were points well situated for trigonometric stations. This suggested that he himself should be the one to test the results of Snell and publish, at any rate, their average in his cyclopædic work. The execution soon followed the conception, and in a short time his results found their way into many cloisters and ecclesiastic homes. One of these was the collegiate institute at Lyons, where Mouton was director of the choir.

This chorister was interested not only in solemn chants and cadenced marches; he found his greatest pleasure in musing on the harmony of nature and the music of the spheres. He saw discord in many conventional systems, especially in the system of measures, where the confusion of varieties was confounded by their uncertain relations. So he set himself to work to devise a system which should have a fixed and natural basis and a simplicity which would commend itself to all peoples. This was the aim of the proposers of the metric system; now let us see how completely this forgotten priest antedated the French academicians by *one hundred and thirty* years, and surpassed them in form and comeliness.

When Riccioli's book reached Mouton, giving the length of a degree of the earth's meridian, the thought came to the latter that here was to be found a unit of measure. So he took the length of one minute of arc and then one-thousandth of a minute; this he called a *virga*; ten virga was a *decuria*, the Latin for by tens; ten decuria was to be a *centuria*, meaning by hundreds; and ten centuria a *milliar*, which was also the length of a minute of the earth's circumference. The virga was to be divided into ten parts, each called a virgula; one tenth of this was a *decima*, meaning a tenth; one-tenth of a decima was a *centesima*, meaning one-hundredth; one-tenth of a centesima was a *millesima*, meaning one-thousandth. From this it can be seen that Mouton developed a decimal system and based it on the size of the earth, the two features which were the boast of the propounders of the metric system, and surpassed them in the terms which he employed, using words taken from only one language, and in their proper etymological sense.

Nor did he stop here. He showed how the length of his unit could be preserved by giving in terms of it the length of the pendulum making an oscillation in one second. This idea was adopted many years later by the English for preserving the length of the yard. In contemplating the great advance here made one must realize that this was in 1665, several years before Huygens announced his investigations regarding the pendulum.

The only way to account for the *complete* oblivion into which this wonderful work of Mouton fell is to say that he was far in advance of his time, and being a comparatively obscure man, his radical views found no adherents. The report of his scheme is published in a book treating of the apparent diameter of the sun and moon, but the book has been practically lost, and after two hundred years of forgetfulness it was only recently brought to light through my instrumentality.

Mouton and Picard, both in the priesthood, were friends, and were interested in the same subjects. Picard had visited Mouton, as he himself confesses, but he does not acknowledge in 1675, when he speaks in glowing terms of the possibility of using the pendulum to fix a unit of measure, that his friend, ten years before, had not only proposed, but had accomplished that very scheme. Picard's quick wit soon enabled him to see that here was a chance to distinguish himself, so, benefiting by what Mouton had done, he hastened to make a measurement of the circumference of the earth near Paris.

This was done with better instruments and greater care than had yet been used. Every part of his work we now know was blemished by errors. Fortunately for us they were of a compensating character, each one destroying some other, until the final result was quite near the truth.

This was the error.

We left Newton just as he had found this result of Picard's. When we return to him we see him rejoicing in the discovery that the diameter of the earth was about 1,000 miles more than he had heretofore supposed. Perhaps this new value might enable him to demonstrate the universality of gravitation. He tried it, and as the figures took their places in the computation under their master's direction and passed through the evolutions at his command, there began to dawn a result which would confirm his hypothesis and make of his theory an accepted fact.

This was an anxious moment for the hopeful philosopher, and so completely did he yield to this anxiety that he was obliged to ask a friend to complete the computation, nor did he find rest for his mind until there came to him the joyful news, "the figures check the fancied truth."

This was the finding.

The French astronomer stumbled more wisely than he knew; the English philosopher harmonized theory with fact, applied the finite to the infinite, and harnessed the worlds with invisible traces.

ARMY ORDNANCE NOTES.

In Washington, May 12, bids were opened in the Ordnance Bureau of the War Department for supplying steel forgings for 8-in., 10-in., and 12-in. guns for coast defense, and for armor-piercing projectiles for guns of these calibers. These bids may be summed up as follows:

Gun Forgings:

	Bethlehem Iron Co.	Midvale Steel Co.
10 sets for 8-in. guns	28¼ cts. per lb.	29 cts. per lb.
10 sets for 10-in. guns	28¼ " "	27 " "
10 sets for 12-in. guns	28¼ " "	27 " "

Armor-Piercing Shells:

	Carpenter Steel Co.	Midvale Steel Co.
104 for 8-in. gun	$15,288	$14,500
208 for 10-in. gun	57 408	58,425
52 for 12-in. gun	24,960	25,000

The bid of the Bethlehem Iron Company was conditioned on an order for all the forgings; if a portion only should be taken, the price named was 30 cents. As an alternative bid, the Bethlehem Company offered to supply 11 sets of 8-in. forgings, 10 sets of 10-in., and 11 sets of 12-in. at $800,000. This bid, however, was for lower-weight forgings than are called for.

It is understood that the contract for the gun forgings

will be awarded to the Midvale Company and that for the shells to the Carpenter Steel Company.

TESTS OF A COMPOUND LOCOMOTIVE.

BY F. W. JOHNSTONE, SUPERINTENDENT MOTIVE POWER, MEXICAN CENTRAL RAILWAY.

THE account given below is of a comparative test of a simple consolidation engine and a compound consolidation engine, in the same service on a mountain section of the Mexican Central Railway.

DESCRIPTION OF ENGINES.

The simple high-pressure consolidation engine, No. 107, selected for the trial, is a Baldwin locomotive of recent design with ample boiler capacity, 20 × 24 in. cylinders and 48 in. drivers. This engine had just been thoroughly overhauled in the Mexico City shops, and was in perfect condition when the tests were made.

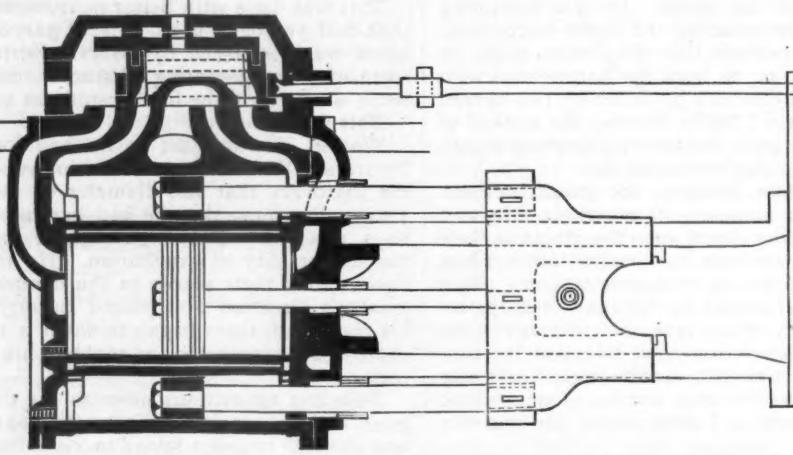
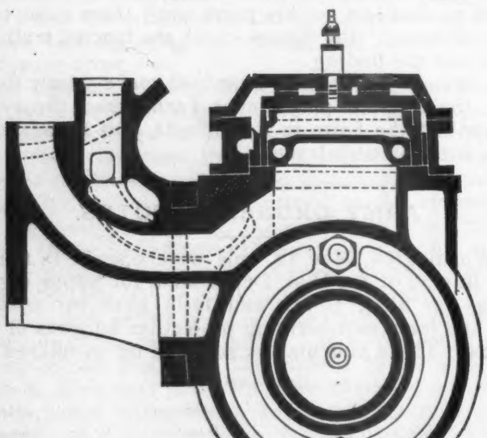


Fig. 1.



The compound engine, No. 66, was originally a Rogers consolidation, built in 1882, with 20 × 24 in. cylinders and 50 in. drivers, weighing 82,000 lbs. on the drivers, fire-box inside of frames and only 6 ft. long. This engine was so inefficient, it was decided when taken out of service for general repairs, to let it lay outside and await its chances of occupying a pit in the shops, which were always crowded with work upon more useful engines.

In August, 1889, the advisability of trying the compound principle on this road was discussed by the General Manager and Superintendent of Motive Power Department, with the view of ascertaining what saving could be effected in the consumption of fuel, which is the heaviest item of expense in the operation of railroads in this country (Mexico). It was decided to make the change on this Rogers consolidation engine. This work was not allowed to interfere with the regular work of the shops, but was carried on from time to time as circumstances would admit, so that it was just about 12 months from the commencement of the work to its completion. As it was necessary to put in a new fire-box, it was decided to increase its length to 9 ft. 4 in. The engine was stripped and the boiler work done outside, while the patterns and castings were being made for the compound cylinders.

The principle adopted by the Superintendent of Motive Power, Mr. F. W. Johnstone, will be readily understood by referring to fig. 1. It will be seen that the high-pressure cylinder, which is 14 in. diameter by 24 in. stroke, is placed within the low-pressure cylinder, which is 30¾ in. diameter by 24 in. stroke, or equal to a cylinder of 24¼ in. diameter after deducting area of high-pressure cylinder and the sleeve surrounding it.

The ratio of the cylinders is three to one.

The low-pressure piston is provided with two rods, and the high-pressure with one; the three rods are secured to the same cross-head, both pistons acting in the same direction.

The valve, which is a very important feature of this design, is so constructed as to distribute steam to both high and low-pressure cylinders, requiring but one valve-stem, which is actuated by the link motion as formerly used on the locomotive, no change having been made in it.

The valve is made in two sections, the outer portion distributing steam to the high-pressure cylinder, and the inner section to the low-pressure cylinder. The inner section is carried by the outer, and has one inch less travel, the outer traveling 6 in. and the inner traveling 5 in. The object of this is to retard the point of cut-off to the low-pressure cylinder and also to reduce the compression on the front of the high-pressure piston. By reference to the indicator cards it will be seen that this has been accomplished in a very satisfactory manner.

For instance, when the high-pressure admission is cut off at 9 in. the low-pressure continues open to the admission of steam for 17 in. On the other hand, the compression on the high-pressure piston which would begin at 9 in. piston travel, were both sections of valve made to move together with the same point of cut-off, does not take place until 17 in. in the high-pressure piston and 19 in. in the low-pressure. With 14 in. cut-off in the high-pressure cylinder we get 20 in. cut-off in the low-pressure cylinder, compression beginning at 20 in. in the high pressure and 22 in. in the low pressure.

A simple arrangement of starting valves enables the engineman to throw the engine into high pressure, steam being admitted through a reduced opening—through the small valve shown on top of the steam-chest in fig. 1—into the low-pressure cylinders; when this is done the high-pressure piston is put into equilibrium, but the two low-pressure pistons act with a force equal to two 24¼ in. pistons; therefore, the engine has a much larger starting power than any high-pressure locomotive of ordinary build.

THE TESTS.

The tests were carefully conducted by Mr. E. V. Sedgwick, Master Mechanic of the San Luis Potosi Division, assisted by Mr. J. H. Ebert, Traveling Engineer.

The crew in charge of engine No. 107 were Messrs. W. H. Spicer, engineer, and N. Campos, fireman. The compound engine, No. 66, was under the charge of Messrs. George B. Ridgely, engineer, and G. A. Daily, fireman. These crews were selected for their ability in getting good work out of their engines, and had been handling these engines for two months before the trial began.

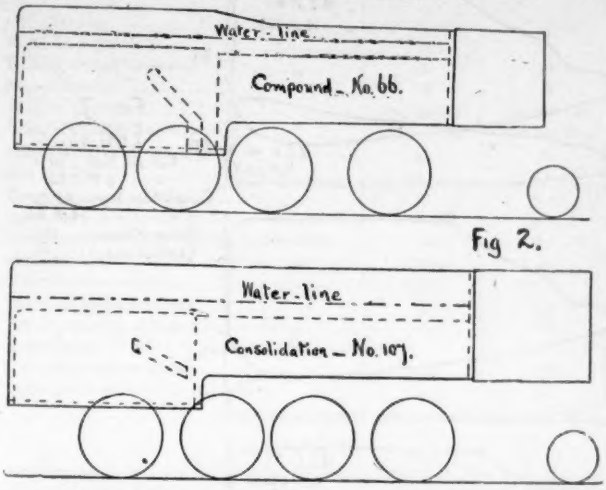


Fig 2.

It was decided to keep the record of trips between San Juan del Rio and Mexico City, as it was always possible to get full trains out of the former place, and these trains generally came through without breaking bulk.

The trains were weighed on track scales after having been made up and just before starting. A coal car was fitted up with a platform in the center provided with platform scales; this car was coupled to back of tank and all coal put upon the tender was weighed in boxes and taken up an incline formed by two planks reaching from platform on coal car to back of tender. The coal car was hauled on each train, as it was desirable to keep a record of the performances of engines on the continuous grade from San Juan del Rio to Cazadero, as well as a record of the performance over the entire division.

While the engine was standing in the engine house at San Juan del Rio steam was kept up with wood, the tender was emptied of all coal, and a quantity thought to be sufficient to take the train to Cazadero was weighed and placed upon it. The boiler was given a half glass of water, and fire was made up with coal which had been weighed out to the engine. This was generally done about 30 minutes before starting out with train. If the coal weighed out to the engine was not sufficient to take the train to Cazadero, more coal was put upon the tender while running, and any coal remaining on the tank after reaching Cazadero was weighed and the amount deducted from the total. The same was done upon arrival at Mexico.

The quantities of water used was arrived at in the following manner. A glass tube 5 ft. long was placed on each side of the tank centrally, fore and aft, and connected to bottom of tank by pipes and suitable stuffing-boxes to make joint at bottom of glass tubes, the upper ends being left open. These tubes were protected by brass pipes with slots cut nearly their entire length to admit of water level in glass tubes being seen. The tank was filled with water, and the level, shown in the two glass tubes was marked O on the brass pipes; water was then drawn off into a barrel which had been carefully weighed, precaution having been taken to fill the barrel and let it soak over night to insure getting the weight of the empty barrel correctly. The barrel was placed upon scales and filled until it contained $333\frac{1}{3}$ lbs. of water, then gauged at water-line. Therefore, in measuring the tanks every three barrels of water drawn represented 1,000 lbs., and the level in glass tubes noted and marked accordingly for each 1,000 lbs. drawn from the tank.

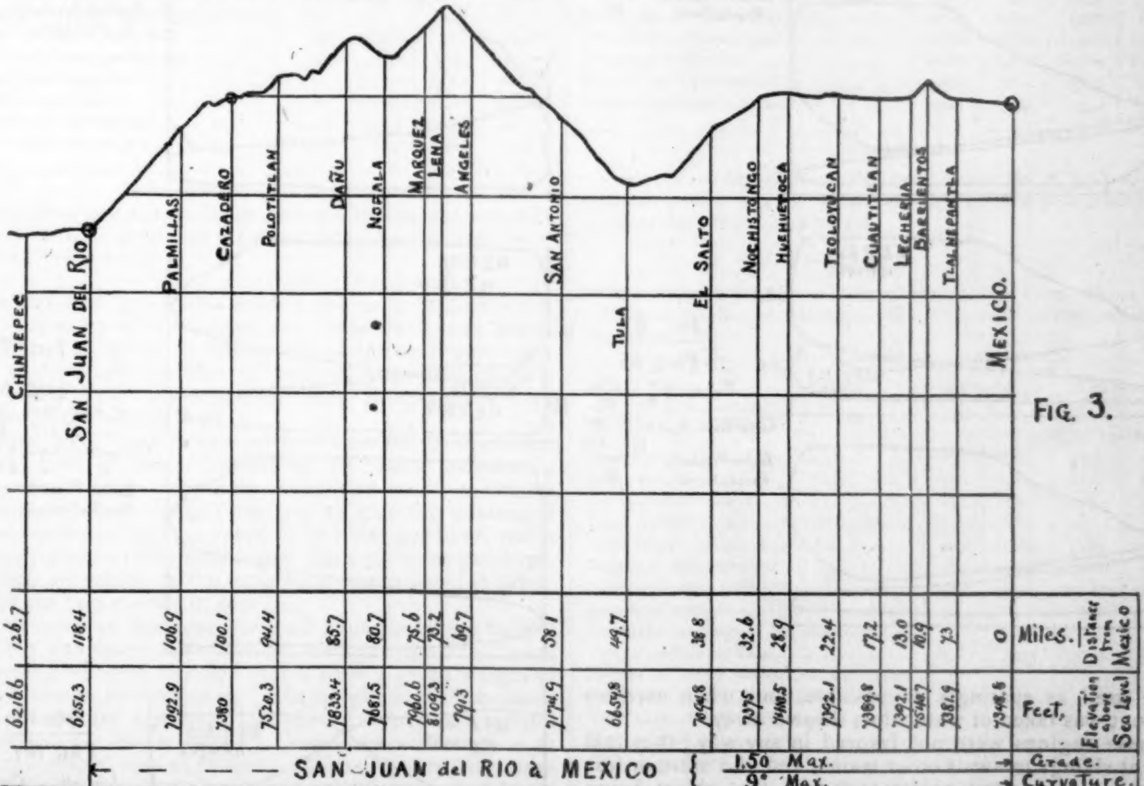


FIG. 3.

Before starting fire with coal at San Juan del Rio the water in the boiler was regulated to half glass and the height of the water in the tank noted, the mean of both tubes being recorded. When a water station was reached the height of water in the tender was noted both before and after taking water. As the 1,000-lb. marks on tubes were about 2 in. apart, it was an easy matter to ascertain accurately the quantity of water used between any given points. The water lost through the overflow of the injec-

tors (Sellers' improved) was so inconsiderable it was not taken account of. On the first trip this waste water was caught and measured and found to be so little that no further effort was made to take it into account. The blow-off cocks

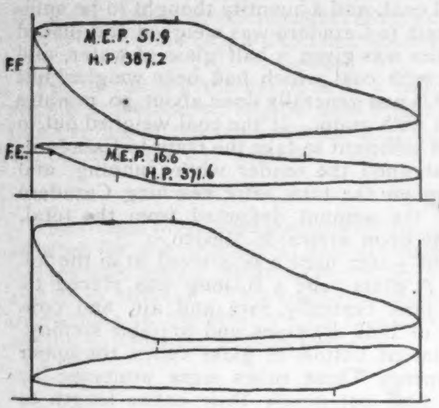


FIG. 4.
ENG. 66.
Cut-off, H.P. .... 9 in.
" " L.P. 16½
Compression begins, H.P. 16½
" L.P. 19
Boiler Pressure 150
Revolutions 200

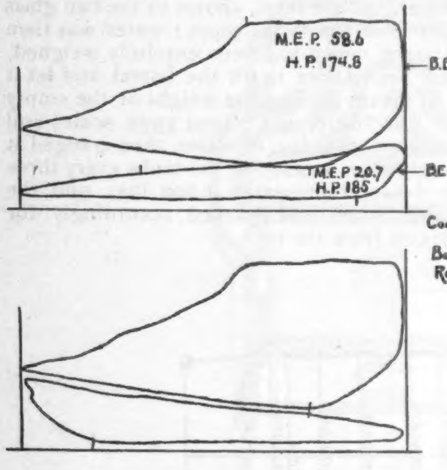


FIG. 5.
ENG. 66.
Cut-off, H.P. .. 10 in.
" " L.P. 17½
Compression begins, H.P. 17½
" L.P. 20
Boiler Pressure .. 150
Revolutions, ... 80

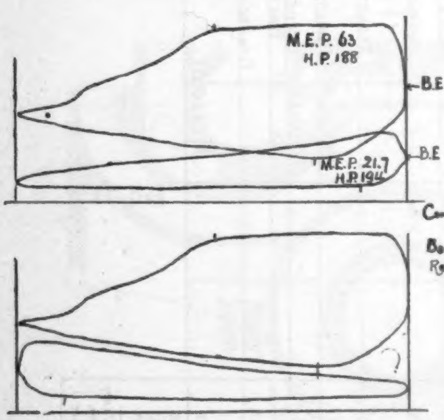


FIG. 6
ENG. 66.
Cut-off, H.P. .... 12 in
" " L.P. 18½
Compression begins, H.P. 18½
" L.P. 21½
Boiler Pressure 140
Revolutions 80

were used as sparingly as possible, and when used no account was taken of water thus thrown away.

These engines were not favored in any way; they laid over at sidings to await other trains, and did more or less switching at various points each trip, the object being to simply keep a record of coal and water used while engines were doing their regular duty in freight service. The engineers were not interfered with, but allowed to handle the engines as they had been accustomed to do.

Indicator cards were taken from each engine merely to show the action of the valve-gear, and not for the purpose of attempting to arrive at the work performed by the engine for the trips, or for any given distance or space of time during the trip, as the horse-power developed by a locomotive is constantly varying, and cards taken but a few minutes apart show that no reliance can be placed upon this method of ascertaining the amount of work done by a locomotive over a section of road, even when the grades are quite uniform. Seeing the necessity for a more

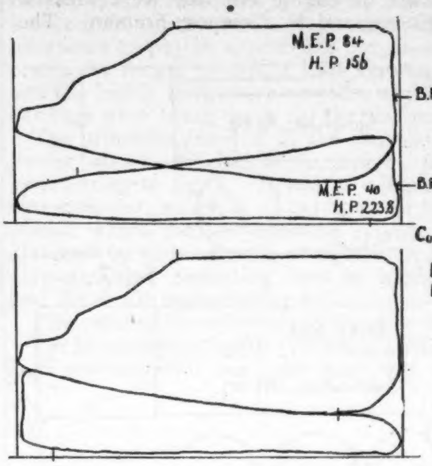


FIG. 7.
ENG. 66.
Cut-off, H.P. ... 14 in.
" " L.P. ... 20
Compression begins, H.P. 20
" " L.P. 22
Boiler Pressure 150
Revolutions 50

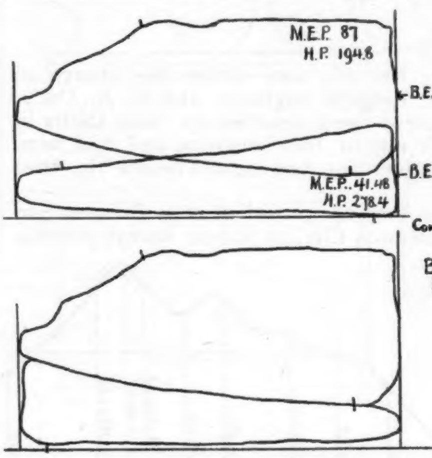


FIG. 8.
ENG. 66.
Cut-off, H.P. .. 16 in.
" " L.P. .. 21
Compression begins, H.P. 21
" " L.P. 22½
Boiler Pressure 150
Revolutions ... 60

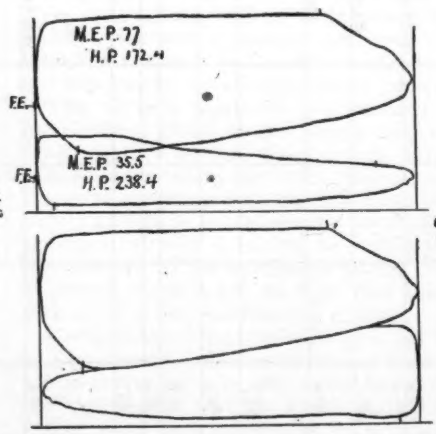


FIG. 9.
ENG. 66.
Cut-off, H.P. .... 18 in.
" " L.P. .. 21½
Compression begins, H.P. 21½
" " L.P. 23
Boiler Pressure .. 150
Revolutions 60

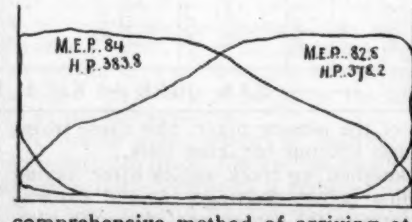


FIG. 10.
ENG. 107.
Cut-off.... 15 in.
Compression begins .. 19
Boiler Pressure .. 140
Revolutions 60

comprehensive method of arriving at the duty of a locomotive in regular service for a trip or for a month's work, the Superintendent of Motive Power decided in the latter part of 1884 to reduce the work done by all engines in freight and passenger service to so many "Units of Work" performed.

TABLE No. 1.
LOCOMOTIVE DIMENSIONS.

LOCOMOTIVES.	No. 66, COMPOUND.	No. 107, CONSOLIDATION.
Cylinder size	14″ × 24″	20″ × 24″
Ratio L. P. to H. P.	3 to 1	...
Driving-wheel diameter	48	48
No. of drivers	8	8
Weight on drivers	100,000 lbs.	100,000 lbs.
Weight of engine and tank	180,000 lbs.	180,000 lbs.
Diameter of shell of boiler	52	60
No. of tubes	200	196
Size and length of tubes	2″ × 11′ : 7″	2¼″ × 13′ : 1″
Grate area in square feet	21.5	30.4
Heating surface of fire-box in square feet	148	152
Heating surface of tubes in square feet	1,200	1,489
Total heating surface	1,348	1,641
Working boiler pressure	150	150
*Water capacity of boiler in per cent	100	118
Steam space of boiler in per cent. with water 6″ above crown sheet	100	168
Grate areas of boiler in per cent	100	141

TABLE No. 2.
PERFORMANCE OF LOCOMOTIVES BETWEEN SAN JUAN DEL RIO AND MEXICO, USING BITUMINOUS COAL FROM THE MINES OF SAN ANTONIO, N. M.

	ENGINE 66.		ENGINE 107.	
Date of trips	Nov. 15, 1890.	Nov. 25, 1890.	Dec. 10, 1890.	Dec. 12, 1890.
Total hours on trip	13.20	13.40	13.13	11.35
Actual running time	10.00	10.40	9.05	7.45
No. of cars in trains	14	15	16	14
Total weight of train, including engine and tender, in tons of 2,000 lbs.	494	489	483	507
Total units of work performed	1,613	1,598	1,477	1,590
Pounds of coal consumed	13,300	13,200	15,800	16,000
Pounds of water used	74,000	73,000	82,000	83,000
Units of work per ton coal	242.6	242.1	186.9	198.7
Units of work per ton of water	43.6	43.8	36.0	38.3

RESULT.

Average of two trips shows the Compound Engine 66 doing 24 per cent. more units of work per ton of coal and 18 per cent. more units of work per ton of water than Engine 107.

One hundred gross tons hauled one mile at a very low rate of speed over a straight and level track was taken as a "Unit of Work." The profile of the road was carefully studied and the line reduced to an equivalent of a straight and level track (curves being compensated were left out of the calculation).

Tables were then formed to facilitate the computation of the units of work performed by each locomotive during the month. Separate tables had to be made up for passenger and freight service, as that for passenger trains was based upon a speed of 31 miles per hour, while the freight train table was based upon 16 miles per hour. This was necessary, as the resistance due to speed is different for the two classes of service.

In arriving at the work done all changes in the weight of trains are taken into account, and the units of work performed between any two points with a given weight of train is shown by the tables. The weight of train is taken from conductors' reports of loaded and empty cars, weight of engine and tender added. Loaded cars average at 24 tons and empty cars at 12 tons. These figures have been checked with the year's gross and net ton-miles and found to be very accurate. This system has been in use on the Mexico Central Railroad for the past six years, and has proved most satisfactory. The performance of light engines on level divisions can thus be compared with that of heavy engines on the mountain divisions. The premiums given for the most economical use of fuel are determined by the units of work per ton of coal shown on Performance Sheet for the month.

These years of experience having established the correctness of this method, it was decided to base the performance of the engines in the tests upon the units of work performed. But to be entirely assured as to the weight of the trains, each train was weighed before start-

TABLE No. 3.
PERFORMANCE OF LOCOMOTIVES BETWEEN SAN JUAN DEL RIO AND MEXICO, USING ENGLISH BITUMINOUS COAL.

	ENGINE 66.		ENGINE 107.	
Date of trips	Jan. 17, 1891.	Jan. 20, 1891.	Jan. 2, 1891.	Jan. 4, 1891.
Total hours on trip	15.20	11.45	9.10	10.45
Actual running time	10.00	7.30	7.20	8.40
No. of cars in train	14	14	15	15
Total weight of train, including engine and tender, in tons of 2,000 lbs.	491	492	424	431
Total units of work performed	1,604	1,607	1,385	1,408
Pounds of coal consumed	12,000	12,090	12,900	13,100
Pounds of water used	69,000	70,000	73,000	74,000
Units of work per ton coal	267.3	266.0	214.7	214.9
Units of work per ton water	46.4	45.9	37.9	38.0

RESULT.

Average of two trips shows the Compound Engine No. 66 doing 24 per cent. more units of work per ton of coal and 21 per cent. more units of work per ton of water than Engine No. 107.

TABLE No. 4.
PERFORMANCE OF LOCOMOTIVES BETWEEN SAN JUAN DEL RIO AND MEXICO, USING ENGLISH PATENT FUEL (BRIQUETTES OF PRESSED COAL).

	ENGINE 66.		ENGINE 107.	
Date of trips	Jan. 11, 1891.	Jan. 15, 1891.	Dec. 27, 1890.	Dec. 30, 1890.
Total hours on trip	12.02	15.25	13.00	11.05
Actual running time	10.00	9 00	7.25	8.45
No. of cars in train	15	14	16	16
Total weight of train, including engine and tender, in tons of 2,000 lbs.	506	491	455	438
Total units of work performed	1,653	1,604	1,426	1,431
Pounds of coal consumed	10,800	10,700	11,900	11,800
Pounds of water used	75,000	73,000	81,000	80,000
Units of work per ton coal	306.0	300.0	239.6	242.5
Units of work per ton water	44.0	43.9	35.2	35.8

RESULT.

Average of two trips shows the Compound Engine No. 66 doing 25.7 per cent. more units of work per ton of coal and 24 per cent. more units of work per ton of water than Engine No. 107.

TABLE No. 5.
PERFORMANCE OF ENGINES ON CONTINUOUS 1⅙ PER CENT. GRADE FROM SAN JUAN DEL RIO TO CAZADERO, USING COAL FROM THE MINES OF SAN ANTONIO.

	ENGINE 66.		ENGINE 107.	
Date of trips	Nov. 15, 1890.	Nov. 25, 1890.	Dec. 10, 1890.	Dec. 12, 1890.
Hours on trip	2.20	2.15	2.10	2 05
No. of cars in train	14	15	16	14
Total weight of train, including engine and tender, in tons of 2,000 lbs.	494	489	483	507
Pounds of coal consumed	4,150	4,100	5,100	5,400
Pounds of water used	19,000	18,000	20,100	23,000
Pounds of water evaporated per lb. of coal	4.5	4.4	3.9	4.2
Pounds of coal burned per square foot of grate surface per hour	84.8	80.0	77.5	85.4
Pounds of water evaporated per square foot of heating surface per hour	5.6	5.9	5.7	6.7
Total units of work performed	499	494	488	512
Units of work per ton coal	241	241	191	190
Units of work per ton water	52.5	44.9	48.5	44.5

RESULT.

Average of two trips shows the Compound Engine 66 doing 26 per cent. more units of work per ton of coal and 15 per cent. more units of work per ton of water than Engine 107.

TABLE No. 6.

PERFORMANCE OF ENGINES ON CONTINUOUS 1⅛ PER CENT. GRADE FROM SAN JUAN DEL RIO TO CAZADERO, USING ENGLISH BITUMINOUS COAL.

	Engine 66.		Engine 107.	
Date of trips	Jan. 17, 1891.	Jan. 30, 1891.	Jan. 2, 1891.	Jan. 4, 1891.
Hours on trip	2.20	2.20	2.10	2.00
No. of cars in train	14	14	15	15
Total weight of train, including engine and tender, in tons of 2,000 lbs	491	492	424	431
Pounds of coal consumed	3,700	3,600	4,000	4,000
Pounds of water used	20,000	19,000	20,000	20,500
Pounds of water evaporated per lb. of coal	5.4	5.2	5.0	5.1
Pounds of coal burned per square foot of grate surface per hour	73.8	71.6	60.8	65.7
Pounds of water evaporated per square foot of heating surface per hour	6.3	6.4	5.6	6.2
Total units of work performed	496	497	428	435
Units of work per ton coal	268.0	276.0	214.0	217.5
Units of work per ton of water	49.6	52.3	42.8	42.4

RESULT.

Average of two trips shows the Compound Engine 66 doing 26 per cent. more units of work per ton of coal and 19 per cent. more units of work per ton of water than Engine 107.

TABLE No. 7.

PERFORMANCE OF ENGINES ON CONTINUOUS 1⅛ PER CENT. GRADE FROM SAN JUAN DEL RIO TO CAZADERO, USING ENGLISH PATENT FUEL (BRIQUETTES OF PRESSED COAL).

	Engine 66.		Engine 107.	
Date of trips	Jan. 11, 1891.	Jan. 15, 1891.	Dec. 27, 1890.	Dec. 30, 1890.
Hours of trip	2.30	2.15	2.00	2.10
No. of cars in train	15	14	16	16
Total weight of train, including engine and tender, in ton of 2,000 lbs	506	491	455	438
Pounds of coal consumed	3,300	3,200	3,700	3,600
Pounds of water used	22,000	20,700	22,500	25,000
Pounds of water evaporated per lb. of coal	6.7	6.5	6.1	5.7
Pounds of coal burned per square foot of grate surface per hour	61.3	66.2	60.6	55.0
Pounds of water evaporated per square foot of heating surface per hour	6.5	6.8	6.8	5.8
Total units of work performed	511	496	460	442
Units of work per ton coal	309	310	249	246
Units of work per ton water	46.4	47.9	40.8	43.1

RESULT.

Average of two trips shows the Compound Engine 66 doing 25 per cent. more units of work per ton of coal and 12 per cent. more units of work per ton of water than Engine 107.

ing, as stated above. The trains were composed of cars bound for Mexico, and only in a few instances was the bulk of the train broken, and when this was done a careful note was taken of this change in weight.

Table No. 2 shows two trips of each engine while using American coal. Table No. 3 shows two trips of each engine using English bituminous coal. Table No. 4 shows two trips of each engine using English patent fuel (briquettes of compressed coal). These 12 trips were made over the entire division of 118 miles; the profile of road is given in fig. 3.

Tables Nos. 5, 6 and 7 show performance of the engines with the three kinds of coal between San Juan del Rio and Cazadero, on a continuous grade of 1⅛ per cent.

The result of the tests show that the compound engine, No. 66, has effected an economy of 25 per cent. in fuel, and from 12 to 23 per cent. in water over the consolidation engine No. 107.

By reference to Table No. 1 it will be seen that the grate area, heating surface, and boiler capacity, both in water and steam space, of the compound is very much less than that of engine No. 107. With these facts in view it is very evident that by compounding engine No. 107 more than 25 per cent. economy can be effected in coal consumption.

It will be noticed that the economy in water is not as great as in coal when comparing the compound with the consolidation, No. 107. This is accounted for by the fact that engine No. 107 has 68 per cent. more cubic feet of steam space, and delivered much dryer steam to its cylinders. Owing to the small boiler of the compound it was impossible to work the engine very hard on account of the quantity of water which was entrained with the steam. The relation of water and steam spaces is shown in fig. 2. This was very noticeable in taking indicator cards, not so much in the low-pressure as in the high-pressure cylinders. When working hard with lever set to cut-off at 18 in. and throttle wide open, it was necessary to carry the water as low in the boiler as was safe to avoid passing water over into the cylinders. No difficulty of this kind was experienced with engine 107.

Given a boiler with the capacity of that of engine No. 107, the compound would most certainly have shown an economy in water equal to that in coal, and in using less water the economy in coal would be greater than these tests have shown.

The indicator cards above referred to are given in figs. 4–10 herewith.

A photograph of the compound engine was received too late to have it engraved for this number of the JOURNAL, but it will be given in our next number.

THE MAXIM FLYING MACHINE.

A RECENT number of the New York *Herald* reports an interesting interview with Mr. Hiram J. Maxim, who spoke as follows about his plans for a flying machine:

"If I can rise from the coast of France, sail through the air across the Channel, and drop half a ton of nitro-glycerine upon an English city, I can revolutionize the world. I believe I can do it if I live long enough. If I die some one will come after me who will be successful where I failed."

Mr. Maxim has built at his workshop near Kent, England, a small flying machine, with a wooden screw as its motive power. The screw revolves all the way from 1,000 to 2,800 revolutions per minute.

"What is your machine like?" he was asked.

"My first machine was a small one. It was an inclined plane, 13 ft. long and 4 ft. wide, and set edgewise against the air. I balanced it on an arm, about 30 ft. in length, revolving in a circumference of 200 ft. The arm was movable, so that it would rise and fall. When the machine traveled at the rate of 30 miles an hour it remained on the same plane. When the speed was increased to 35 miles it began to rise. At 90 miles it pulled its guy wires with such force that it broke them, and now we have to keep it chained. All our experiments were conducted with the greatest accuracy. Delicate machines measured the speed per minute and per hour, the push and lifting power of the screw, the horse power of the motor and every other factor."

"But this little machine can hardly be of practical use?"

"Very true; but now I am at work on a large machine, built of silk and steel that will do on a large scale what the other machine does on a smaller scale. We found by experiment that one horse power will carry 133 lbs. at the rate of 75 miles an hour. We proved also that our screw would easily lift 40 times as much on a plane that it propelled as it could push. I have built a motor weighing 1,800 lbs., and which pushes 1,000 lbs. It will therefore lift 40,000 lbs. The weight of my engines, generator, condenser, water supply and petroleum, and of two men is 5,000 lbs. So you see what a margin I have left."

"What is the size of your large machine?"

"It will be 110 ft. wide and 40 ft. long. It will be propelled by two immense wooden screws, nearly 18 ft. in diameter, looking very much like the screws of ocean steamers, only with broader blades. The steam is generated by heating copper by petroleum, and is condensed after being used, so that we get along with two gallons of water. The boiler is of the finest Whitworth steel, and we will use about 40 lbs. of petroleum per hour."

"How are you going to test the machine?"

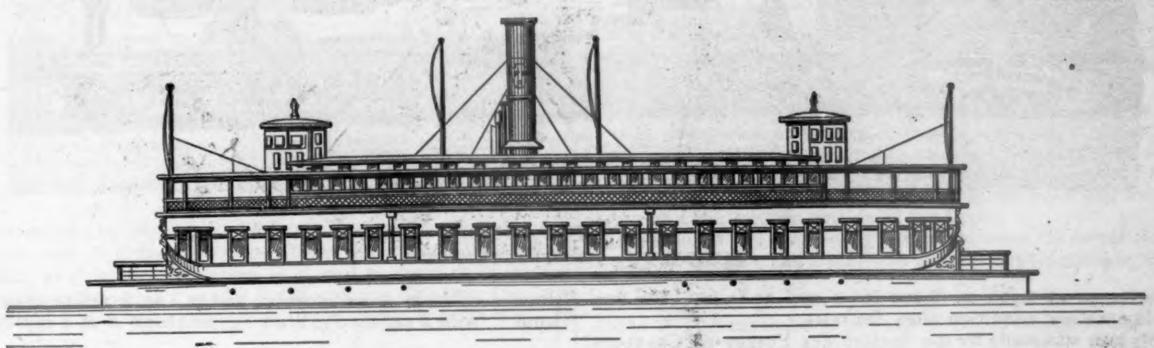
"It will be placed at an angle of about 1 ft. in 18 in. on a railroad track 12 ft. wide. At 30 miles an hour it will barely skim along, the pressure of the air underneath it being then equal to one pound for each square foot, or sufficient to just lift it. At 35 miles an hour it will begin to rise, and as the speed increases it will mount higher and higher. When you want to descend you will slacken speed, or if you wish to proceed on a straight line on a certain height you come back to 30 miles an hour. It can be done as sure as fate. I have spent $45,000 already upon it, and I did not enter upon the work until I was convinced that the idea was practical."

"But suppose you should tip over?"

"Oh, no," said Mr. Maxim, with a laugh. "You may be sure that that is one contingency that we are bound shall not occur. It will be impossible for the machine to fall forward, to sink backward or fall over."

THE PENNSYLVANIA TERMINAL IMPROVEMENTS.

THE accompanying illustration is an elevation of the new ferry-boat *Cincinnati*, recently launched from the yard of Samuel L. Moore & Sons, at Elizabethport, N. J.



DOUBLE SCREW FERRY-BOAT "CINCINNATI."

It is intended for the Pennsylvania Railroad ferry between New York and Jersey City. The hull is entirely of iron; the upper works are of wood, but the boilers and engine are entirely surrounded by an iron casing.

The boat is double-decked, according to the new pattern adopted by the Pennsylvania Railroad Company, thus largely increasing the capacity for passengers.

The *Cincinnati* is 206 ft. long over all; 180 ft. long between perpendiculars; 65 ft. wide over all; 45 ft. molded breadth; 16 ft. 6 in. in depth.

In her machinery the company has followed the example first set on the Hoboken Ferry in the *Bergen*, and has substituted double screws for the side wheels heretofore in use. The boat has two four-bladed screws 8 ft. in diameter, one at each end, both being carried on the same shaft. The shaft is driven by two compound engines which can work up to 1,100 H.P. The engines are being built at Newburg, and we hope to give some further description of them hereafter. The *Cincinnati* will be the fifth double-screw ferry-boat on the Hudson.

In this connection it may be noted that the elevated line of the Pennsylvania Railroad and the new station in Jersey City are so far completed that two of the elevated tracks were brought into use May 17. The local trains are now running over these and into the new station, but the through trains will continue to use the old line until the third and fourth tracks on the elevated structure are finished.

The platforms in the new station are elevated above the street level. From them passengers will pass directly upon the upper decks of the ferry-boats. They will not be obliged to descend to the main deck at all, since the company has completed a bridge over West Street in New York, which is on a level with the second deck of the boats.

Foreign Naval Notes.

THE ENGLISH 110-TON GUNS.

AFTER many trials and failures it is believed that satisfactory results with the English 110-ton gun have at last been attained. The weapon put on board the *Sans Pareil* in lieu of that which had a curvature and a drooping tendency in its tube has gone through some of its trials without showing evidence of the defects noticed in the other guns. It will be remembered that in the later guns and in this new gun stiffening bands were put on the bores or muzzles, and in this new gun the stiffening process has gone a step further. Nine of these guns have now been made. Six are in the service, two each on the *Benbow*, *Victoria*, and *Sans Pareil*. Some of them have a slight drooping tendency in the muzzle, but this, it is thought, does not affect their efficiency.

CHILIAN TORPEDO EXPERIENCE.

The destruction of the insurgent iron-clad *Blanco Encalada* by a torpedo does not seem, from the latest accounts—which are still incomplete—to afford much ground for boasting by torpedo advocates. While the ship was sunk by a Whitehead torpedo, it appears that she was taken unawares and was entirely unprotected, no torpedo-nettings nor other methods of defense being used. Even in this unguarded state it was only the seventh torpedo which reached her, six having been sent out previously, all failing to reach the mark. Indeed, one of them went far astray, and blew up part of a dock. Of course it is not easy to decide from partial accounts, but the incident seems to show that, while a torpedo is formidable when it does strike the mark, it can hardly be considered a reliable weapon yet.

THE ENGLISH NAVAL EXHIBITION.

The Naval Exhibition recently opened in London seems, from all accounts received, to be very successful. Apart from the historic interest attaching to the memorials of the *Victory* and other old-time war-ships, there is a large collection of guns and other modern naval appliances, showing the latest methods and the gradual steps by which improvements have been made and the present development reached.

THE CANET GUN.

The accompanying illustrations, from *Le Yacht*, show a 32-cm. (12.6-in.) Canet gun built for the Japanese coast defense ship *Itsukushima*—which was illustrated and described in the JOURNAL for February last, page 83—and recently tested at La Seyne, France. This gun is a built-up gun of the Canet type, which has been very favorably received in Europe, and has a length of 40 calibers, the total length of the piece being 12.80 m. (42 ft.). In the illustrations fig. 1 shows the gun on its temporary mount ready for trial; fig. 2 shows it loaded on railroad trucks for removal.

As will be seen from fig. 2 the gun has no trunnions, but is held by the teeth or toothed grooves formed in the lower part of the outside hoop. The powder chamber is larger than the bore proper, and the rifling is progressive, with a final inclination which experience has shown to be best adapted to give the projectile the speed of rotation needed to secure stability and directness of flight. The breech mechanism is of the screw type, with interrupted threads.

The test of this gun consisted of 20 shots, with charges varying from 264 to 562 lbs. of powder and projectiles varying from 762 to 1,033 lbs. in weight. The highest result obtained was

with a charge of 562 lbs. of powder and a projectile weighing 988 lbs. The muzzle velocity was 2,308 ft. per second; the calculated penetration in wrought-iron plate at the muzzle was

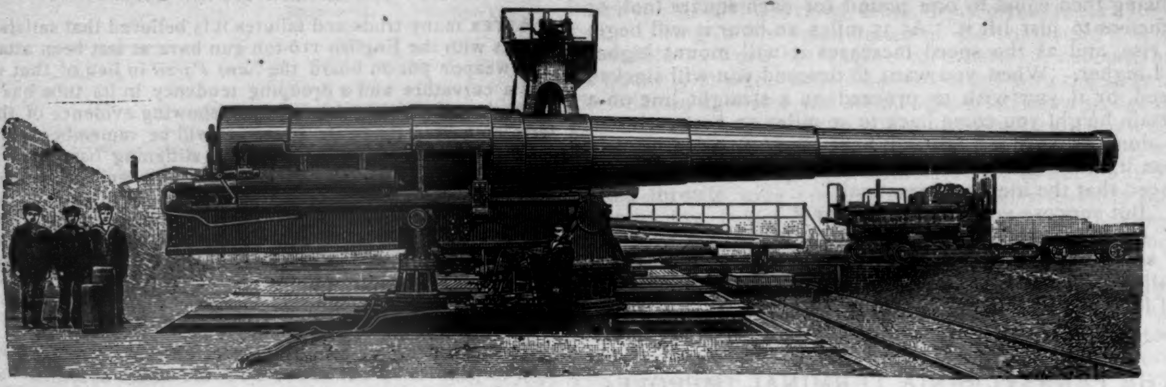


Fig. 1.

Fig. 2.

THE CANET 32-CENTIMETER GUN.

45.28 in., or at 2,500 m. (8,200 ft.) it was 35.83 in. The gun was in excellent condition after the tests.

This gun was made by the Société des Forges et Chantiers at Havre; its total weight is 145,464 lbs., a little over 72½ tons. It will be mounted in a turret of special construction, and handled by hydraulic machinery.

The French papers consider these results excellent, and claim that the Canet gun has shown itself to be a more powerful weapon than the Armstrong or the Krupp guns of greater weight.

THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.

(*Continued from page 231.*)

CHAPTER XI.—(*Continued.*)*

AN OVAL.

Problem 78. *To construct an oval or egg-shaped figure, fig. 255.* If $A B$ is the width or minor axis of the figure, bisect it at E, and from E as a center, with a radius $A E$ equal to one-half of $A B$, draw the circle $A C B F$, and draw a perpendicular $C E D$ to $A B$. From A and B draw lines through F and produce them indefinitely. From A and B, with a radius $A B$, draw arcs $A G$ and $B H$ cutting $B F$ and $A F$ extended at G and H. From F as a center, with a radius $F G$, describe the arc $G D H$ to meet the arcs $A G$ and $B H$, which will complete the oval.†

CAM.

Problem 79. *To draw a three-centered cam, fig 256.* Let $A B$ and C be the three centers. Through these points draw the lines $A B$, $B C$ and $C A$, and extend them indefinitely beyond the centers. Then from A, with any radius, as $A d$, draw the arc $d h$, cutting the line $B A$ extended in h and $C A$ in d. Then from C as a center, with a radius $C d$, draw the arc $d f$ intersecting $C B$ at f. From B as a center and a radius $B f$ draw $f i$; from A as a center and $A i$ as a radius draw $i e$; from C, with a radius $C e$, draw $e g$, and from B as a center and

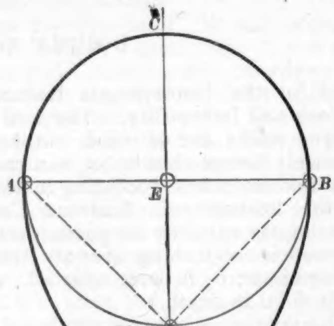


Fig. 255

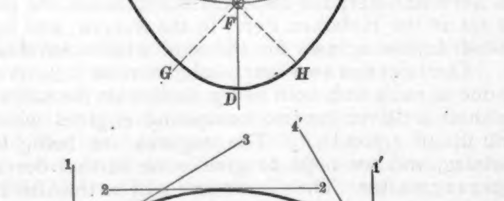


Fig. 256.

$B g$ as a radius, draw $g h$, which will complete the outline of the cam. The positions of the centers A, B and C will be de-

* Attention is called to an error in fig. 252, published last month. The figures in the fourth ordinate were engraved .81603; they should be .86603.

† From "Linear Drawing," by Ellis A. Davidson.

termined by the circumstances for which the cam is used. Such a cam has the property that any two parallel lines drawn tangent to it, as 1 1, 1′ 1′; 2 2, 2′ 2′; 3 3, 3′ 3′ or 4 4, 4′ 4′ will always be the same distance apart.

THE PARABOLA.

A parabola is a curve of which any point is equally distant from a fixed point, called its *focus*, and from a given straight

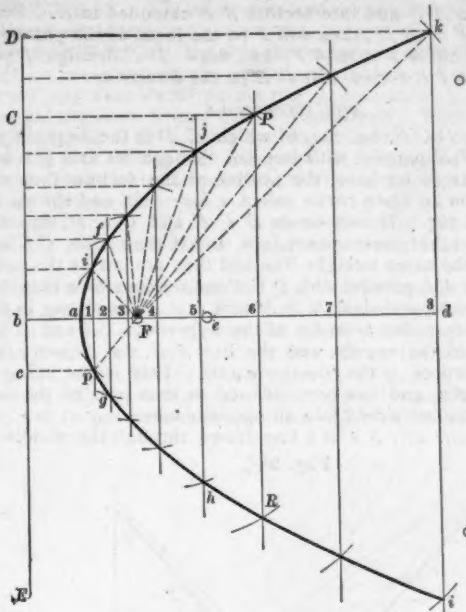


Fig. 257.

line called the *directrix*. Thus in fig. 257 if F be the fixed point and $D\,E$ the given line, then the distance $P\,C$ of any point, as P in the curve from $D\,E$, will be equal to its distance $P\,F$ from the focus F, and $p\,F$, the distance of p from the focus, is equal to $p\,c$, and a, the *vertex* of the curve, is at an equal dis-

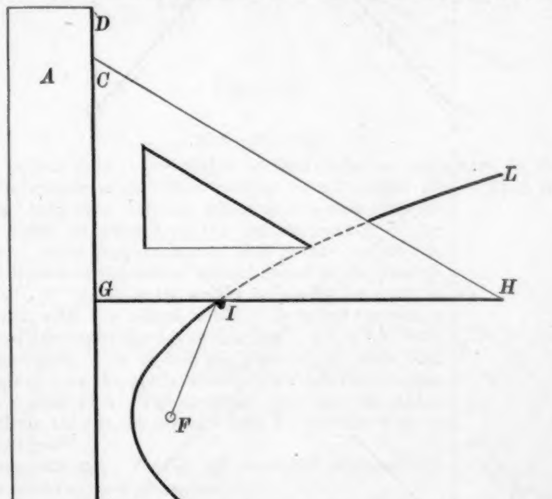


Fig. 258.

tance from F and b. Consequently the vertex a is always midway between the focus and directrix.

A straight line, as $P\,R$ or $k\,i$, drawn across the figure at right angles to the axis is a *double ordinate*, and either half, as $d\,k$ or P 6, is an *ordinate*. A line $a\,d$ drawn through the focus and middle of the curve is called the *axis* or an *abscissa*. A parabola is an open curve—that is, its two extremities never meet, no matter how far they are extended.

The properties of the parabola, which have been explained, afford an easy method of describing it mechanically, and we have

PROBLEM 80. *To draw a parabola when the directrix $D\,E$, fig. 258, and the focus F are given.*

Place a straight edge, $A\,B$, so that its edge coincides with $D\,E$, and let $C\,G\,H$ be a right-angled triangle or square, one side $C\,G$ of which bears against the straight edge on the side $D\,E$. Take a thread, the length of which is equal to the side $G\,H$ of the triangle, and attach one end at H and the other at the focus F. Place a pencil I against the thread and the triangle, so as to draw the thread tight. Then if the side $C\,G$ be moved along the line $D\,E$ the pencil will describe a parabola, of which F is the focus and $D\,E$ the directrix; for the distance $F\,I$ will be equal to $I\,G$, for every position of the ruler.*

PROBLEM 81. *To lay off a parabola when the directrix $D\,E$, fig. 257, and the focus F are given.*

Through the focus F draw a line $b\,d$ perpendicular to the directrix $D\,E$. This is the *axis* of the curve. Draw lines parallel to $D\,E$ and perpendicular to the axis through any points, as 1, 2, 3, 4, etc. These points should be nearer together next to the apex a than they are toward the open end of the figure, but their exact position is not important. With the focus F as a center and the distance 1 b, of the point 1 from the directrix, as a radius, describe arcs cutting the vertical line passing through 1 at i and p. The intersections i and p of the arcs with the vertical will be points in the curve. Proceed in the same way for each of the other points 2, 3, 4, etc. Thus with a radius 6 b and from F describe arcs cutting the vertical line which passes through 6 at P and R, which will give two more points in the curve. When as many points as may be required are laid down in this way, the curve may be drawn by making a template for the portion lying on one side of the axis, or a close approximation to the true curve may be drawn with compasses by finding by trial a center e on the axis from which the portion $f\,a\,g$ can be drawn. Other centers m and n can be found in the same way, from which the parts $f\,j$ and $g\,h$ can be described, and the remaining parts $j\,k$ and $h\,i$ can be drawn from centers outside of the figure.

PROBLEM 82. *To lay off a parabola when the length $A\,B$, fig. 259, of its axis and that of its greatest double ordinate 8′ M are given.*

First Method.—Through A, the vertex of the parabola, draw 8 $A\,N$ perpendicular to its axis $A\,B$. Through 8′ and M, the

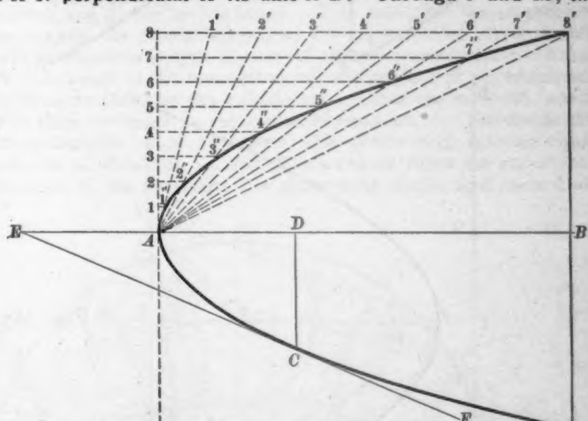


Fig. 259.

ends of the double ordinate, draw 8 8′ and $N\,M$ parallel to $A\,B$, thus forming a rectangle 8 8′ $M\,N$, whose sides are respectively equal to the axis and double ordinate. Divide the ordinate 8 A into any number of equal parts and the side 8 8′ into the same number of equal parts. From the vertex A draw lines A 1′, A 2′, A 3′, etc., to the points of division on 8 8′. From the points of division, 1, 2, 3, etc., on 8 A draw lines parallel to $A\,B$ and intersecting A 1′, A 2′, A 3′, etc., at 1″, 2″, 3″, etc. These intersections will be points in the curve.

Second Method.—Let $A\,B$, fig. 260, be equal to the length of the axis, and $L\,M$ be a double ordinate. Extend $A\,B$ and make $A\,C = A\,B$. From L and M draw lines $L\,C$ and $M\,C$ to C. Divide the sides $L\,C$ and $M\,C$ into any number of equal parts C 1, 1 2, 2 3, etc., and draw the lines 1 1′, 2 2′, 3 3′, 4 4′ 5 5′, 6 6′, and 7 7′. The lines will be tangents to the parabola, which may then be drawn so as to touch each of these lines.

PROBLEM 83. *To lay off a parabola with ordinates.*

Let $A\,B$, fig. 261, be the axis and $C\,B$ an ordinate of a parabola. Divide the axis or abscissa $A\,B$ into eight equal parts,

* Davies's "Analytical Geometry."

and draw ordinates from the points of division perpendicular to $A\ B$, as shown above $A\ B$. Multiply the length of $C\ B$ by the numbers on the ordinates above the axis and lay off the distances thus obtained on the ordinates from $A\ B$. The points

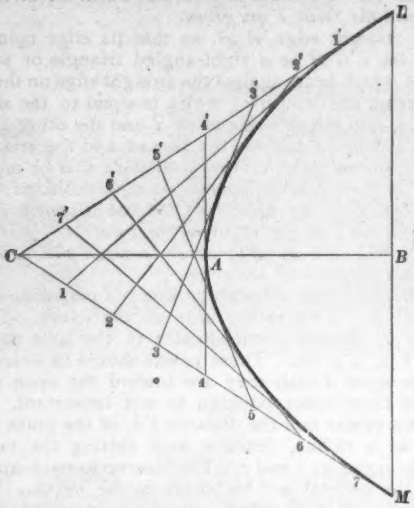


Fig. 260.

Fig 261.

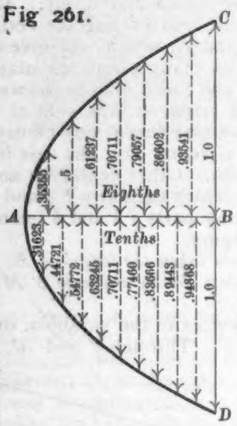
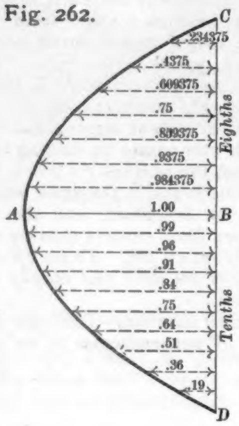


Fig. 262.



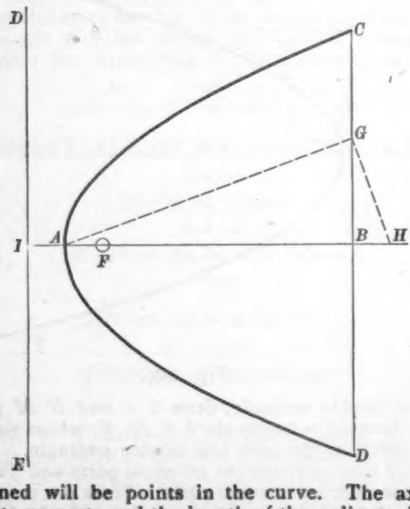


Fig 263.

thus obtained will be points in the curve. The axis may be divided into 10 parts and the length of the ordinate $B\ D$ multiplied by the numbers below $A\ B$, and the curve can then be laid off as before.

PROBLEM 84. *To construct a parabolic curve by another method.*

Divide the ordinate $C\ B$, fig. 262, into eight equal parts, and draw perpendiculars to it through the points of division; the length of these perpendiculars will be determined by multiplying the length of the axis $A\ B$ by the respective number on each horizontal line above $A\ B$ in fig. 262. The ordinate $B\ D$ may be divided into tenths and the length of $A\ B$ multiplied by the numbers on the horizontal lines below $A\ B$, and the parabola laid off as described in the preceding problem.*

* The two preceding methods of laying out a parabola are taken from Molesworth's "Pocket-Book of Engineering Formulæ."

PROBLEM 85. *To draw a tangent to a parabola at any point.*

Let C, fig. 259, be the point. From C draw $C\ D$ perpendicular to the axis $A\ B$. Extend $B\ A$ to the left and make $E\ A$ equal to $A\ D$. A line drawn through E and C will be tangent to the parabola at the point C.

PROBLEM 86. *To find the focus and the directrix of a parabola, the axis and an ordinate being given.*

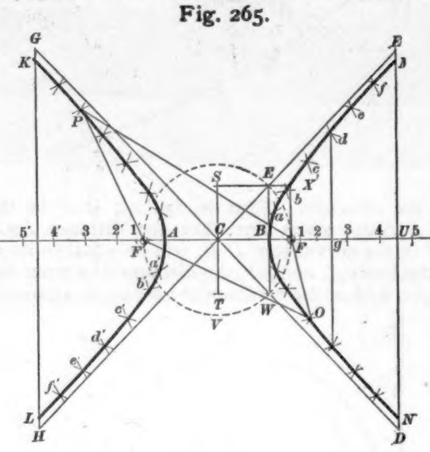
Let $A\ B$, fig. 263, be the axis and $C\ B$ an ordinate. Bisect $C\ B$ at G, and from A draw $A\ G$. Through G draw $G\ H$ perpendicular to $A\ G$ and intersecting $A\ B$ extended in H. From A lay off $A\ F = B\ H$; then will F be the focus of the parabola. From A lay off $A\ I =$ to $A\ F$, and draw $D\ E$ through I perpendicular to $I\ B$; then will $D\ E$ be the directrix.

THE HYPERBOLA.

If a cone, $D\ C\ E$, fig. 264, of which $E\ D$ is the base, is cut by a plane $J\ B$ parallel with but not through its axis $Q\ C$ and perpendicular to its base, the outline of the section thus obtained will be an open curve called a *hyperbola*, and shown by $N\ B\ M$, fig. 265. If two cones $D\ C\ E$ and $C\ G\ H$, fig. 264, are placed so that their apexes join, and if their axes, $Q\ C$ and $C\ R$, are in the same straight line and they are cut by the same plane, $J\ B\ S\ A\ I$, parallel with $Q\ C\ R$ the sections thus obtained will form two hyperbolas, $N\ B\ M$ and $L\ A\ K$, as shown in fig. 265, which are called *branches* of the hyperbola. A and B are the *vertices* of the curves, and the line $A\ B$, the distance between the vertices, is the *transverse axis*. This is the same as $A\ B$ in fig. 264, and has been defined as that part of the axis which if continued would join an opposite cone.

The *conjugate axis* $S\ T$ is a line drawn through the middle of

Fig. 265.



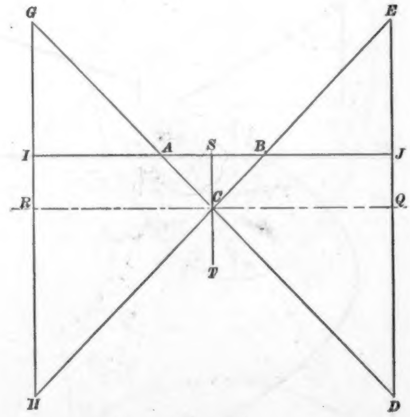


Fig. 264.

the tranverse axis and at right angles to it. It is equal to twice the distance $S\ C$, fig. 264, of the intesecting plane $I\ J$, from the axis of the cone from which the hyperbola is produced.

$F\ F'$, fig. 264, are the *foci* of the two curves, and C midway between A and B is called the *center* of the curve.

The nature of a hyperbola is such that the *difference* of the distances of any point in the curve, from the foci, is always the same, and is equal to the transverse axis $A\ B$. Thus if from the point O we draw lines $O\ F$ and $O\ F'$ to the foci F and F', then the difference of the length of these lines will be equal to $A\ B$; or if from the point P similar lines $P\ F$ and $P\ F'$ be drawn, their difference will also be equal to $A\ B$.

PROBLEM 87. *Having the transverse and conjugate axes, to find the foci of an hyperbola.*

Let $A\ B$, fig. 265, be the transverse axis of two branches of

an hyperbola. The ends of the axis will coincide with the vertices of the two curves. From *A* erect *E B*, a perpendicular to *A B*, and make it equal to half the conjugate axis, or to the distance *S C*, fig. 264, of the intersecting plane from the axis of the cone. Then from *C*, fig. 265, the middle of *A B* as a center and with *C E* as a radius describe a circle *E F V F'* cutting *A B* extended at *F* and *F'*, which will be the foci of the hyperbola.

PROBLEM 88. *The transverse and conjugate axes being given, to lay off an hyperbola.*

Draw *A B*, fig. 265, equal to the transverse axis. Find the foci *F F'*, as explained in the preceding problem. From *F* and *F'* lay off any number of points 1, 2, 3, etc., 1', 2', 3', etc., at equal distances from *F* and *F'* respectively. Then with radii *A* 1, *A* 2, *A* 3, etc., and from the foci as centers describe arcs cutting each other at *a*, *b*, *c*, etc., and *a'*, *b'*, *c'*, etc. These will give points in the curve through which it may be traced.

PROBLEM 89. *To draw a hyperbola when its length B C, fig. 266, its breadth D E and transverse axis A B are given.*

Construct the parallelogram *D E F G* and subdivide its upper and lower sides, *G D* and *F E*, and each of the ordinates *D C* and *C E* into the same number of equal parts 1, 2, 3, etc., and 1', 2', 3', etc. From the points 1, 2, 3, etc., draw lines to *A*, and from 1', 2', 3', etc., draw lines to *B* which will cut each other. Their respective points of intersection will be points in the curve, through which it may be traced.

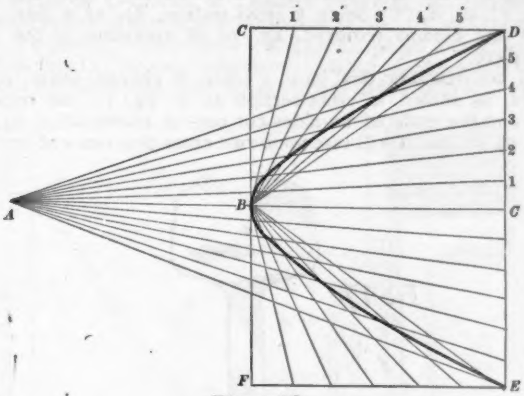


Fig. 266.

THE CYCLOID.

A *cycloid* is a curve which is described by any point in the circumference of a wheel rolling on a straight line. Thus let *A*, fig. 267, be a circle or wheel and 0–16 a straight line equal in length to the circumference of the wheel. In rolling from 0 to 16 a point 0 in the circumference of the wheel would move in the path 0, 1''', 2''', 3''' 5''', 6'''–16, and if a pencil be held in contact with the wheel while it is rolled from 0 to 16 it will describe the curve 0, 1''', 2''', 3'''. 4''', 5'''–16.

The circle *A* is called the *generating circle*, and the point 0 in the circle which describes the cycloid is the *generator*. The straight line 0–16 on which the circle rolls is the *director* and 8''' 8 is the *axis* of the cycloid.

PROBLEM 90. *To lay off a cycloid mechanically for a wheel of any diameter.*

Ascertain by calculation or from a table of diameters and circumferences the length of the circumference of the generating circle. Then lay off a straight line 0–16, whose length is equal to the circumference. Divide the latter and the straight line into any number of equal parts 1, 2, 3, etc., and 1', 2', 3', etc. Place the wheel so that the point marked 0 in its circumference will coincide with 0 in the straight line, and mark the point on the paper. Then roll the wheel toward the right and make the point marked 1' on the wheel to coincide with 1 on the straight line, and again mark the position of 0' at 1'''. Proceed in this way, making each of the points 2', 3', etc., in the circumference of the wheel coincide with 2, 3, etc., on the straight line, and for each position of the wheel mark the position of 0' at 2''', 3''', 4''', etc. The marks 1''', 2''', 3''', etc., thus laid down will be points in the cycloid.

PROBLEM 91. *To lay off a cycloid with instruments for a wheel of any diameter.*

Ascertain as before the circumference of the wheel, and draw a straight line 0–16 equal in length to the circumference, and subdivide them both as described. Draw the generating circle *A* on the perpendicular 8' 0 and tangent to 0–16. Through the center 0 of *A* draw a horizontal line *A*–16'' parallel to 0–16. From the points of division 0, 1, 2, 3, etc., erect perpendiculars to 0–16 intersecting *A*–16''. The point 0 will be the beginning of the cycloid. From 1'' as a center and with the radius of the generating circle describe an arc 1 1''' tangent to 0–16. Take with a pair of dividers a chord 0 1' from the generating circle, and set off this distance 1 1''' from 1 on the arc. The point thus laid down will be a point in the cycloid. Proceed in a

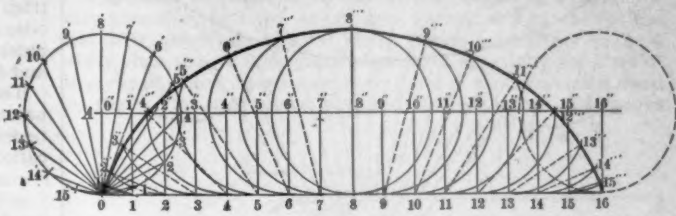


Fig. 267.

similar way, and from 2'' as a center draw an arc 2 2''', and with a chord 0 2' lay off from 2 on the arc 2 2''' the point 2''', which will be another point in the cycloid. Continuing in the same way draw arcs from each of the points 3'''–16''' and lay off successive points 3'''–16''' through which the cycloid may then be drawn.

THE EPICYCLOID.

If the generating circle *A*, fig. 268, rolls on the circumference of another circle 0–16, instead of on a straight line, the curve described by a point 0 in the circumference of the generating circle will be an *epicycloid*. The one which is stationary is called the *fundamental circle*. If the generating circle rolls on the exterior of the fundamental circle the curve described is called an *exterior epicycloid*. If it rolls on the inside, as indicated in fig. 269, it is called an *interior epicycloid* or *hypocloid*.

PROBLEM 92. *To describe an exterior epicycloid mechanically.*

Ascertain as before the circumference of the generating circle and also of the fundamental circle. Then multiply 360° by the former and divide by the latter. This will give the number of degrees in the circumference of the fundamental circle, which will be equal in length to that of the generating circle. From *B*, the center of the former, lay off the angle 0 *B* 16, which has been ascertained by the calculation. Draw the arc 0–16, which will then be equal to the circumference of *A*. Subdivide the circumference of *A* as before, and divide 0–16 into an equal number of divisions. From *B* as a center draw the arc 0''–16'' through *A*, the center of the generating circle, and then draw

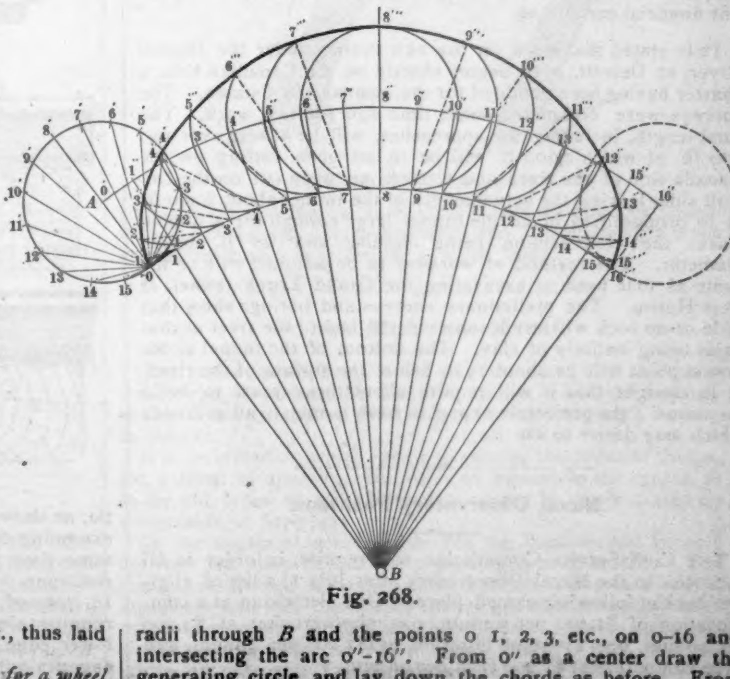


Fig. 268.

radii through *B* and the points 0 1, 2, 3, etc., on 0–16 and intersecting the arc 0''–16''. From 0'' as a center draw the generating circle, and lay down the chords as before. From each of the points 1'', 2'', 3'', etc., on the arc 0''–16'' draw

arcs 1 1‴, 2 2‴, 3 3‴ as in the preceding problem, and with chords 0 1′, 0 2′, 0 3′, etc., lay off points on the arcs which will be points in the required curve.

PROBLEM 93. *To lay off an interior epicycloid.*

Draw the arc 0–16, fig. 269, of the fundamental circle and the generating circle *A* on the inside as represented. Subdivide the circle and the arc as in the preceding problem, and lay off

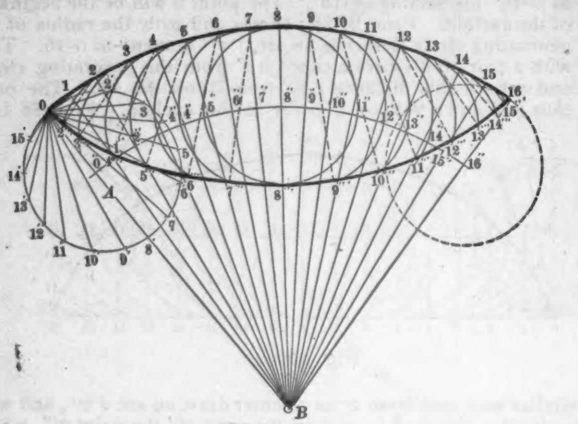


Fig. 269.

the points of the curve with chords 0 1′, 0 2′, 0 3′, etc., on arcs drawn on the inside of 0–16. The method of doing this will be clear from the diagram and the elucidation of the preceding problems. When the diameter of the generating circle is equal to half that of the fundamental circle, the epicycloid becomes a straight line, being in fact a diameter of the larger circle.

(TO BE CONTINUED.)

Canadian Notes.

A NEW work which is being urged upon the Government of the Dominion of Canada is the construction of the proposed Trent Valley Canal, which is to connect Georgian Bay with Lake Ontario, thereby giving Canada an inside line to the upper lakes entirely within its own territory. The length of this waterway will be about 195 miles, but a considerable portion of this is covered by lake and river navigation, so that less than 60 miles of canal will have to be excavated. Should it be built, vessels coming from Lake Superior, Lake Huron, or Lake Michigan can avoid going through the Detroit River and Lake Erie entirely. The line is one which must have suggested itself to any one who has ever examined a map of the lakes. It is understood that the government approves of the project, but is not prepared to begin construction at once on account of the present financial conditions.

IT is stated that work on the new tunnel under the Detroit River, at Detroit, is to be begun shortly on the Canadian side, a charter having been obtained for the company in Canada. The surveys were completed some time ago for this work. The total length, including the approaches, will be a little over 12,000 ft., of which 2,100 ft. will be in an open cutting on the Canada side of the river and 1,500 ft. an open cut on the Detroit side, leaving the actual length of the tunnel about 8,400 ft. It is proposed to make the tunnel large enough for a double track, the cross-section being circular and 27 ft. inside diameter. The method of working to be adopted will be the same as that used in excavating the Grand Trunk tunnel, at Port Huron. The preliminary surveys and borings show that little or no rock will be encountered, the bed of the river at that point being entirely of clay. The bottom of the tunnel at the lowest point will be about 75 ft. below the surface of the river. It is thought that it will require about three years to build the tunnel; the projectors expect to have it open to all railroads which may desire to use it.

Naval Observatory Positions.

THE Civil Service Commission will require, in order to fill vacancies in the Naval Observatory after July 1, a list of eligibles for the following-named places: One electrician at a compensation of $1,500 per annum, one photographer at $1,200 per annum, one assistant librarian at $1,200 per annum, and three computers at $1,200 each per annum.

The examinations for the different grades will be as follows: For electrician the examination will be both theoretical and practical, covering the subjects of electric batteries, currents, resistance, and measurements, together with the construction and maintenance of electric-lighting plants, and the methods of transmitting power by electric currents. For photographer the examination will cover, first, the ordinary photographic manipulations, together with the different processes used in the art; second, the character of the necessary optical apparatus, together with the application of photography to astronomical work. The assistant librarian examination will include the translation into English of short paragraphs of scientific German, French, Latin, Italian, and Spanish writings, the bibliography of scientific, especially astronomical, literature, modern library methods, and systems of classification. The examination for computers will include algebra, geometry, logarithms, trigonometry, and elementary astronomy.

These examinations may be taken at any date and place named in the schedule of the commission. A special date will be fixed at Washington as soon as a sufficient number of applications is received to justify it.

Recent Patents.

McGIEHAN'S RAIL-JOINT.

A NEW form of rail-joint is covered by patent No. 431,611, issued to Isaac S. McGiehan, of New York. This is shown in figs. 17–19, fig. 17 being a cross section, fig. 18 a side view with the clamps removed, fig. 19 an elevation of the joint complete.

In constructing this joint a piece of channel-beam iron is taken, as shown in cross-section at *A*, fig. 17, the requisite size and the ends of its sides cut out, as shown at *c c*, figs. 18 and 19, so that it will rest upon two cross-ties, one end on each

McGIEHAN'S RAIL-JOINT.

tie, as shown in figs. 18 and 19, with the sides of the channel extending downward between the ties to form a truss and at the same time providing a flat upper surface for the rail ends to rest upon. Two clamps are then provided, as *E E*, figs. 18 and 19, formed, as shown in cross-section, with two jaws, one running along its top edge and the other running along its lower edge, as shown at *m* and *n*. The jaw *n* fits under and engages with the lower side of the channel-bridge *A*, and the

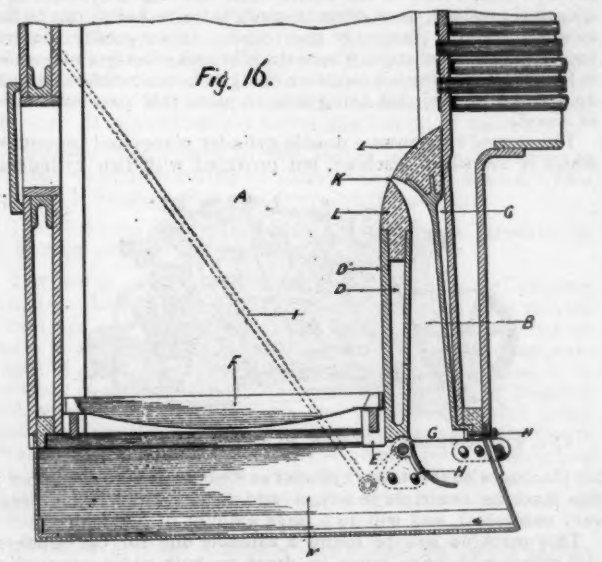
jaw *m* passes over the rail-base. After these are in place, the bolts *d* are passed through the clamps and sides of the channel-beam bridge, and when these are drawn together the jaws *m* slide up on the rail-base until the rail is finally seated upon the channel-beam bridge, and by utilizing the bevel of the rail-base as a wedge for the jaws *m* to slide over, together with the bolts *d*, sufficient clamping force is obtained to practically convert the whole into a solid structure, so that the joint is quite as strong as any other part of the rail. There is placed on top of the channel-beam bridge a piece of chemically prepared or tar paper *s*, which acts as a cushion for the rail to rest upon and destroys the metal contact between the rails and the bridge, and it also prevents the parts from rusting together.

The lower jaws *n* of the clamps *E* do not slide under the bridge when the bolt is tightened, as is usual with such joints. The lower jaw *n* is provided with a shoulder, which strikes the outside of the bridge and prevents it from sliding further under, thus throwing the entire movement to the upper jaw, which is shaped so as to utilize the bevel of the rail-base to slide over, and thereby produce a more substantial and rigid grip than could be otherwise obtained.

In order to prevent the rails from creeping, when necessary four depressions are provided in the corners or edges of the channel-beam bridge *A*, as shown at *o o*, fig. 18, and the edge of the flange of the rail is bent down to fit into these depressions, so that when the clamps *E* are in position it would be impossible for the ends of the rail to draw out.

CHUBB'S SMOKE CONSUMER.

MR. WILLIAM J. CHUBB, of London, England, has patented the arrangement of fire-box represented in fig. 16, which consists of a tuyere or funnel-shaped passage *G*, which may extend entirely across the fire-box or furnace-chamber, and by which air is drawn into the tuyere from below the fire-bars and discharged



CHUBB'S SMOKE CONSUMER.

through one or more narrow mouths in such wise as to mingle with the unconsumed gases and smoke that are making their escape from the furnace, whereby the desired more perfect combustion is effected. This tuyere *B* is made of metal, is surrounded with air spaces, and is so formed that one or more blocks *L* of fire-brick, fire-clay, or other similar material of the required shape can be held in suitable seatings in the top of the casting, to protect it from the action of the fire. A door *H* is placed at the bottom *G* of the tuyere, by which the admission of air to the fire-box may be regulated.

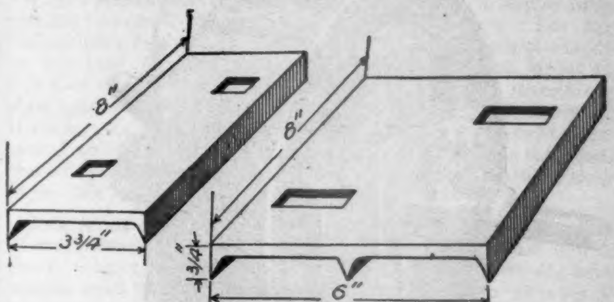
Manufactures.

A Quadruple-Expansion Engine.

THE new steam tug *Dorothy* recently completed at the yard of the Newport News Ship Building Company, and intended for very heavy work—towing car-floats in New York Harbor—is of steel, 90 ft. long over all, 18 ft. beam, and 8½ ft. draft. The chief peculiarity of the *Dorothy* is that she has a quadruple-expansion engine, designed by Mr. Horace See. This engine is of the double-crank tandem type, with cylinders 9⅝ in., 13½ in., 18½ in., and 26 in. in diameter, and 22 in. stroke. The cranks are placed at right angles with each other, and the valve gear is provided with cut-off attachments. The upper cylinders are so arranged that the pistons of the lower cylinders can be examined without difficulty. The engine is intended to work at a pressure of 180 lbs. The propeller is of iron 7 ft. in diameter. Steam is furnished by a steam boiler of the cylindrical return tubular pattern 9 ft. 6 in. in diameter and 10 ft. 6 in. in length.

Track Appliances.

THE use of tie-plates under the rail for protecting a tie is now very common, and the advantages gained are so substantial that their use is extending. There is also a tendency to use a wider plate than was originally adopted, especially for lines of heavy traffic, and at points where there is unusual strain upon the ties. The wide plate is found to have other advantages

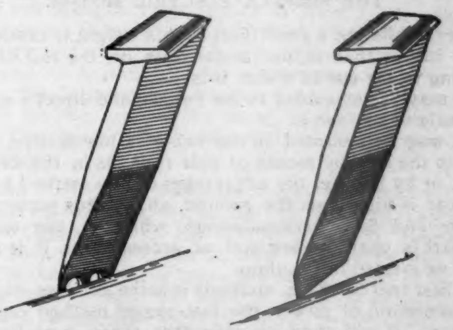


THE SERVISS TIE-PLATE.

besides preserving the tie, such as preventing the canting of the rail, and consequent side rail of the head on curves, and preserving through gauge.

Many forms of tie-plates have been tried, but those having a plain surface have not been altogether successful, having a tendency to work loose and to rattle when the rails are not tightly spiked down. The accompanying illustration shows the Serviss plate, which is provided with flanges which serve the double purpose of sustaining the plate itself and of entering the tie and holding the plate in its place.

The second cut shows the Davies spike, which is of steel with a double head. When driven at an angle, as shown, and in



THE DAVIES LOCK SPIKE.

combination with the tie-plate, these spikes making lock fastenings, it gives great lateral resistance and, it is claimed, a much greater resistance than the use of a rail brace.

A New Multipolar Motor.

THE latest development in the way of motors is of the multipolar type, is called the Simplex motor, and was recently shown to representative electricians at the company's rooms, in Boston.

It is an invention which seems to reverse the order of things, for, instead of applying the power or current to the center, as in the old types of machinery; the energy is concentrated on the outside or periphery.

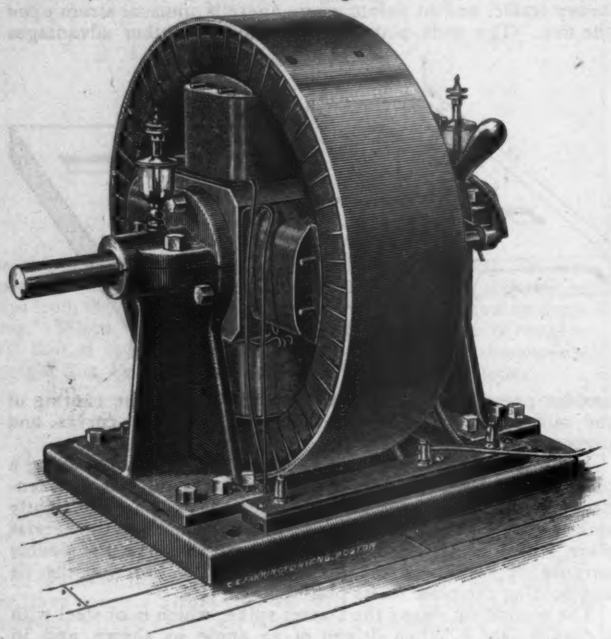
In the matter of construction lies the fundamental rupture between the Simplex and the prevailing type of motors. The location of the field is on the inside, and thus it becomes tenfold more compact, and diminishes the weight to one-fourth that of those now used. It also has the shortest possible magnetic circuit, consequently can be energized with less wire, and naturally less current. The armature being in the form of a ring,

which encircles the field, can be extended to any diameter; thus an enormous initial can be obtained, and the speed of such an armature may be very slow, and the ventilation of coils, being the best possible, there is no liability of "burn-outs," for the armature is always comparatively cool.

This armature, revolving as it does, only from 100 to 700 revolutions per minute instead of from 2,000 to 3,000, proportionately reduces the friction on bearings, and requires less attention to lubrication and replacing worn parts, and further, obviates the noise consequent upon the more rapid machines—a gain in one direction at least, which the public will readily understand and appreciate.

The application of the Simplex motor to vehicles, it is claimed, may be obtained in several ways:

1. Directly, by making the motor a wheel of the vehicle. In this case, all of the benefit of weight is obtained for traction



THE SIMPLEX ELECTRIC MOTOR.

purposes, while but a small part of this weight is carried by the vehicle itself; that is, the motor rests on the rail or ground, according to the use to which it is put.

2. It may be suspended to the vehicle and directly connected to the axle of the same.

3. It may be mounted in the cab of a locomotive, and connected to the axle by means of side rods, as in the steam locomotive, or by belting, the advantages of this method being that the motor is high from the ground, and is thus protected from moisture and dust accumulations, while at the same time every part is open to view and as accessible as if it were stationary or located in the shop.

The first two of these methods involve no loss whatever in the transmission of power, the last-named method only a very slight one. It will thus be seen that there is no limit to the working capacity of this machine, the mechanical construction being capable of enlargement to an unlimited extent without materially increasing its weight, whereas the old types must necessarily be kept within a certain fixed weight.

Several of these motors have been ordered by well-known companies, and it is said that practical tests will soon be made in service. One of the motors is shown in the accompanying illustration.

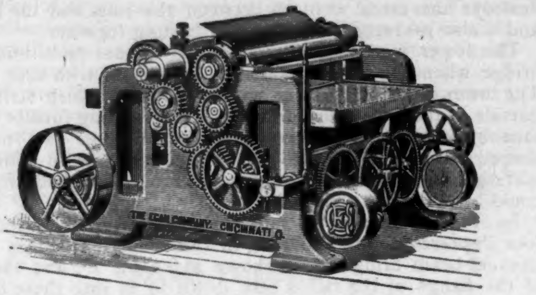
Smoothing Planers for Wood-Work.

In recent years a great advance has been made in planing machinery for giving a surface to all kinds of wood. The accompanying cut shows one of the latest developments in this direction, a heavy planer and smoother. The one shown is a 30-in. size, but the tool is made in six sizes, to take in from 24 to 42 in. wide.

The means of adjusting the bed is claimed as the best known, making it solid and free from vibration, having more support beneath it than can be obtained in any other way.

The feed consists of four powerfully geared feed-rolls of large diameter, and the fluted or front feed-roll is driven by expansion gearing, making it impossible for the roll to lift out of gear when taking a heavy cut, making a feed that can be relied upon as being first-class in every particular. The feed-rolls are weighted on an improved principle, the weights being adjustable to give more or less pressure as desired. There are two speeds to the feed, and it is stated that this machine will do smoother work at its fastest feed than has heretofore been attained on any other smoothing planer at a much slower speed.

The cylinder is four-sided, so as to use either two or four knives, as may be desired. It is double belted, and the feed is

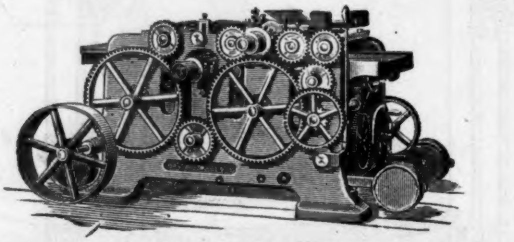


No. 4 EXTRA HEAVY PLANER AND SMOOTHER.

run directly from it. There are pressure-bars on each side of the cylinder, arranged on a new principle, to work to the circle of the head, thus preventing all tearing out of wavy-grained or knotty stuff, either narrow or wide, or clipping of ends, which is so common with many smoothing planers.

One of the greatest advantages of this machine, especially in the wide sizes, is that the stock can be run diagonally under the cylinder, which is far better than running a cylinder in a diagonal position, as it permits straight belts being run to the cylinder, and the planing of short stuff. It is specially adapted for planing framed stock where straight and cross-grained wood is built up, and which heretofore has given car-builders trouble on account of their not being able to plane this particular kind of wood.

The second cut shows a double-cylinder planer and smoother, which is the same machine, but provided with two cylinders,



No. 9 DOUBLE CYLINDER PLANER AND SMOOTHER.

for planing with the under cylinder as smooth as with the upper; this machine is simple to adjust and to operate. It has been very successful, and will do a large amount of perfect work.

This machine will be found a valuable one for car-builders and others who have stock to dress on both sides, especially wide or hard wood. They are made by the Egan Company, whose works are at Nos. 194–214 West Front Street in Cincinnati.

A New Steam Heating System.

A new system for the continuous heating of trains by steam is now being introduced by the Morton Safety Heating Company of Baltimore, which not only promises well, but has also shown good results so far as tested. The advantages claimed for this system are summed up as follows:

1. The heat is stored in an earthenware tube, enclosed in an iron pipe; steam is applied for five or ten minutes only, and sufficient heat is stored to keep the car comfortable for several hours.

2. It is the only system by which a regular temperature can be maintained at all times and in all weather.

3. When at night, the locomotive is detached, and the train is left standing out of doors for ten or twelve hours without steam, the train will be from 35° to 45° next morning. With any live steam or hot-water system the train would be cold in one hour.

4. It is safe; there being no steam or hot water remaining in our pipes, there is no danger of scalding, in case of accident to the train.

5. It is *economical;* because steam need only be taken from the locomotive when it is stationary, or running down grade, and our material will not freeze in the coldest weather.

6. It is so simple that any one can be instructed to manage it in a few minutes.

The first claim is supported by an accidental test on the Grand Trunk, where, on March 11, the engine of a passenger train heated by this system broke down near Island Pond, and a freight engine was attached; the train was without steam for five hours, and on arrival at Montreal the thermometer registered 65° in the cars. As to the second, on January 29 last, on the Intercolonial Railway, a train was run between Halifax, N. S., and St. John, N. B., 275 miles, and a regular temperature of from 70° to 72° maintained the entire distance, by application of steam for five minutes each hour.

During the past winter this system was tested practically by daily use on the Norfolk & Western; the Chicago, St. Paul, Minneapolis & Omaha; the Richmond, Fredericksburg & Potomac; the Canadian Pacific; the Grand Trunk and the Intercolonial roads.

It is well adapted to street cars also, and has been in use on the Baltimore City and Baltimore Traction lines; in Dover, N. H., and on the West End Company's lines in Boston.

The Morton Company has its headquarters at No. 106 East Saratoga Street, Baltimore. The officers of the company are E. G. Kenly, General Manager, and Eugene Carrington, General Superintendent.

General Notes.

THE special pipe-joint grease made by the Joseph Dixon Crucible Company has given excellent results when used for mud-plugs in locomotive boilers and similar purposes, and its use is extending.

THE Mason Regulator Company, Boston, has acquired the exclusive right to make and sell the piston-throw indicator patented by Mr. Frank Robinson, of Bangor, Master Mechanic of the Maine Central Railroad. The device is very simple, and shows a car inspector at once the condition of the air-brake pistons. It is a convenient device and one much needed.

THE New York office of the Taylor Iron Works is now in the new Central Building at Liberty and West streets. This building is becoming a center for railroad business.

THE Johnson Railroad Signal Company has removed its New York office to No. 47 Broadway.

THE works of the Cleveland City Forge & Iron Company contain 23 hammers in all, of which seven are upright and the others are helve hammers. The heaviest of these hammers has a 10 ton head with an 8-ft. stroke. Among the achievements of these works are the manufacture of a shaft 4 ft. in diameter on the bearings; plate bending rolls 32 in. in diameter and weighing 64,740 lbs. each, and a triple-expansion crank shaft weighing 60,810 lbs. The machine shop connected with these works is equipped with unusually heavy tools for handling the largest masses of metal coming from the hammers. One of their lathes, built in Scotland, will take in a shaft 60 ft. in length.

THE Ball & Wood Company has bought the recent patents and inventions of Frank H. Ball, and will engage in the manufacture of high-speed, automatic cut-off engines. The new company is building extensive shops at Elizabethport, N. J., which will be equipped with the best tools, with a view to building the improved Ball engine. Mr. Thomas C. Wood is President, and Charles R. Vincent Secretary and Treasurer.

THE Carlisle Manufacturing Company, Carlisle, Pa., is about to erect a brick building 300 ft. in length, to replace the frog shop, which was recently destroyed by fire. The shop is now occupying temporary quarters.

THE Bethlehem Iron Company at Bethlehem, Pa., has now a Yale & Towne hydraulic testing machine which has a capacity of 300,000 lbs. This machine is chiefly used in testing the armor-plates and gun forgings which the company is now making for the United States Government.

The business offices of this company, with that of the President, Mr. R. B. Linderman, have recently been removed from their old location in the works to the new building of the Lehigh Valley Railroad in Bethlehem.

AN addition to the general office building of the Lehigh Valley Railroad at South Bethlehem, Pa., has just been finished, nearly doubling its size. The company now has offices of ample size, very handsomely and conveniently arranged. The engineering offices now located at Wilkes-Barre are being removed to South Bethlehem, and also the Paymaster's office and those of the Coal Department.

THE shops of Tippett & Wood, Philipsburg, N. J., are filling a large contract for ore chutes and dock equipment for the Sagua Iron Company in Cuba; that company is largely owned by the Thomas Iron Company, of Hokendauqua, Pa. Tippett & Wood are also building a stand-pipe for the water-works at Henderson, N. C., and one for Winter Harbor on Grindstone Neck in Maine.

THE Allentown Rolling Mill Company, Allentown, Pa., has added to its extensive works a spike mill with a capacity of 20 tons a day, which started up May 11. In this mill new patented machinery is in use; it is in charge of a gentleman who was long engaged in the business in Brazil, Ind. The company has nearly completed a new factory for its switch and signal department, which is in charge of Mr. Frederick S. Guerber.

THE Philadelphia Bridge Works of Cofrode & Saylor have recently received the following important orders: For the Philadelphia & Reading Railroad, 20 girder and truss bridges on the Port Reading Extension, from near Bound Brook to Kill Von Kull; for the New York Central Railroad, three large plate girder bridges on the Rome, Watertown & Ogdensburg Division; for the Central Railroad of New Jersey, three bridges, two of which are for six tracks; for the Pennsylvania Railroad, two bridges at Trenton, N. J.; also, a large iron machine shop to be built at Jersey City.

THE latest transatlantic fast steamer is the *Fürst Bismarck* of the Hamburg-American Company's line. The new ship is 500 ft. long, 57 ft. 6 in. beam, and 38 ft. deep. There are twin screws, each driven by a triple-expansion engine capable of working up to 8,000 H.P. There are nine double-ended boilers, and also an additional boiler on the upper deck for running the pumps and auxiliary engines.

THE factory and office of Joel H. Woodman & Company, manufacturers of car seats, panels, veneering, etc., has been removed to Fifteenth and Clinton streets, Hoboken, N. J. The new buildings are large, covering an area of 200 × 200 ft., and have facilities for doing a great amount of work. This firm has also recently bought out the New York business of Foster & Petersen; that firm will be reorganized as Petersen Brothers, and removed to Portsmouth, N. H.

THE steamboat *Rhode Island*, of the Providence & Stonington Steamship Company, has recently been supplied with a new engine by the Morgan Iron Works in New York. She now has a compound beam engine, with high-pressure cylinder 64 in. diameter and 7 ft. stroke; low-pressure cylinder 84 in. diameter and 12 ft. stroke. The low-pressure cylinder is connected to the forward end of the beam; the high-pressure cylinder to the after part of the beam, in front of the connecting rod. The paddle-wheels are of the ordinary type and 34 ft. in diameter.

Two new steel ferry-boats are under construction at the Marvel yard in Newburg, N. Y., for the Hoboken Land & Improvement Company, and the first of them, the *Bremen*, was launched May 12, and towed to New York to receive her engines. The hulls of these boats are 220 ft. long, 40 ft. beam, and 17 ft. deep. They will have a screw at each end, both screws being on the same shaft and driven by compound engine, having two high-pressure cylinders, 20 in. diameter, and two low-pressure, 36 in., all being 28 in. stroke.

THE new steel steamer *E. C. Pope*, launched from the Wyandotte yard of the Detroit Dry Dock Company on May 2, is, it is claimed, the largest freight carrier on the lakes. The general dimensions are: Length over all, 334 ft. 6 in.; length of keel, 314 ft.; beam, 42 ft.; depth of hold, 24 ft. The boat will have a propeller 13 ft. 2 in. in diameter, driven by a triple-expansion engine, with cylinders 22 in., 35 in., and 56 in. in diameter and 44 in. stroke. Two steel cylindrical boilers, each 14 ft. 3 in. by 11 ft. 6 in., will furnish the power at a working pressure of 160 lbs. The hold is divided into eight separate water-tight compartments, which may contain 950 tons of water ballast. The boat is fitted with a Worthington ballast pump, a Providence steam windlass and steam capstans furnished by the American Ship Windlass Company, Williamson steam-steering gear, and all the modern appurtenances of a first-class steamer. Three pole masts, without sails, are carried.

THE Rhode Island Locomotive Works in Providence have recently completed 5 engines for the New York, New Haven & Hartford, 2 moguls for the Fort Worth & Rio Grande, and have orders for 21 others, including 4 moguls for the Maine Central, 3 switch engines for the Old Colony, 5 for the Mil-

waukee, Lake Shore & Western, 6 for the Wabash, and 3 for the Mexican Central.

DURING the month of April the Schenectady Locomotive Works turned out 33 engines, including six 18 × 24 ten-wheel passenger, three 17 × 24 six-wheel shifting engines for the Chicago, St. Paul, Minneapolis & Omaha; two 20 × 24 consolidation engines for the Chicago & Eastern Illinois; six 18 × 24 ten-wheel passenger, four 19 × 24 ten-wheel freight, and five 17 × 24 six-wheel shifting engines for the Chicago & Northwestern; four 18 × 24 six-wheel shifting engines for the Fitchburg Railroad; one 17 × 24 Forney engine for the Erie & Wyoming Valley, and two 16 × 20 narrow gauge 12-wheel freight engines.

THE Brooks Locomotive Works, Dunkirk, N. Y., have recently received orders for 10 freight engines for the Wisconsin Central Railroad and for 20 locomotives for the Cleveland, Cincinnati, Chicago & St. Louis Railroad.

THE Rogers Locomotive Works are building 18 locomotives for the Nashville, Chattanooga & St. Louis and 8 heavy engines for the Columbus & Hocking Valley. They have also received an order for 10 ten-wheel freight engines for the Houston & Texas Central.

THE Pittsburgh Locomotive Works have received orders from the Wheeling & Lake Erie Railroad for three yard engines and six ten-wheel freight engines for that road.

The Smillie Car Coupler.

THE effect of the adoption of the Master Car Builders' type of couplers has been to stimulate inventors all over the country, and has led them to make many improvements in the details of couplers of the vertical plane type. The illustrations which are given herewith represent a form of coupler which has been

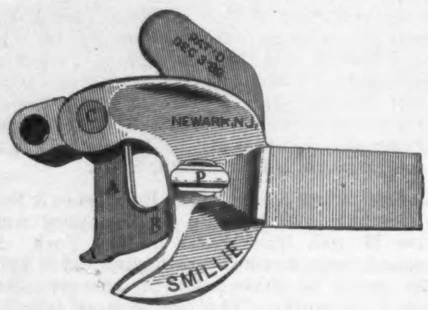


Fig. 1.

evolved through the stimulus referred to. As will be seen from the engravings, it is made on what are called the Master Car Builders' "lines"—that is, the contour of the parts which engage with each other are made of the form recommended by the Master Car Builders' Association.

Fig. 1 is a perspective plan and fig. 2 a similar view, with the head of the coupler shown in section. The knuckle *A* is of a Z shape, and in fig. 1 is shown in the position it occupies when open, and in fig. 2 it is shown closed. When the locking pin *P* is withdrawn the knuckle can be swung into the open

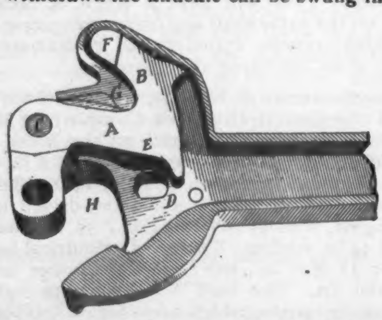


Fig. 2.

position shown in fig. 1. The inside arm *B* of the knuckle then comes below the pin and supports it. When the knuckle is completely open the pin rests on the end of the arm *B* in a step *F*. The weight of the locking pin and its connections thus holds the knuckle in its open position for coupling. When two open couplers come together the force of the blow raises the locking pin out of the depression *F*, the knuckle is turned on the pivot pin *C*, and the arm *B* is pushed back from under the pin into the position shown in fig. 2. In this position it no longer supports the locking-pin, which then falls 6 in. into the hole *D*, and the knuckle bears against the pin at *E*, and is thus securely locked. At the same time the arm *B* is held in the recess made to receive it in the coupler-head. It is there enclosed by a solid wall of metal, so that with the locking and pivot pins it forms a triple combination to resist the pulling force on the couplers. Even if the pivot pin *C* should be broken or removed, the knuckle would be held in its position by the locking pin, the arm *B* and the metal in front of it.

From fig. 2 it will be seen that, when coupled to another car, the knuckle bears against the locking pin at *E*. The reaction of this strain is resisted by the pivot pin *C*, or by shoulders *H* on the back of the knuckle. If the pivot pin *C* was broken or removed, the shoulders referred to and the metal at *C* would still be sufficient to resist the pulling strain on the coupler, thus forming a double lock, as was shown by the following tests, which were made by Mr. N. O. Olsen, on a Fairbanks testing machine, in April of this year. The knuckles were steel from two different makers, the draw heads malleable iron:

1.	Tension,	with pivot pins,	knuckle	breaking	at	111,600 lbs.
2.	"	" " "	"	"	"	119,490 "
3.	"	without pivot pins,	"	"	"	106,560 "
4.	"	with " "	drawhead	"	"	139,640 "
5.	"	without " "	knuckle	"	"	135,360 "

Test No. 3 was with coupling locked without pivot pins and pulled as in service, both knuckles having been used in 1st and 2d tests, broke as above. Test No. 4 was with pivot pins, the drawhead breaking at 139,640 lbs. Test No. 5 was without pivot pins, the knuckle breaking at 135,360 lbs.

The double lock was in as good condition after the tests as before.

The locking pin must be lifted 6 in. to unlock, therefore the coupler will not unlock by any jolt of the train in motion.

The unlocking device consists of the usual shaft and lever arms, carried in bearings attached to the end of the car, but instead of a chain to lift the pin a clevis is used, which holds up the pin when the knuckle is set not to couple.

This coupler is made by the Smillie Coupler and Manufacturing Company, at 91 Clay Street, Newark, N. J. The New York office is at 52 Broadway.

The Baltimore Cable Railroad.

WORK on the cable road of the Baltimore Traction Company is practically completed. The only work now being done on the tracks is on South Howard Street, where the operations of the Belt Railroad have caused the street bed to sink, throwing the cable track out of level.

The gripmen who are to manage the cars are taking lessons daily, and workmen are going over the line and the machinery looking for defects. Experimental trips are being made daily, and the management expect to have the road in full operation by June 10.

Ground was broken for the road March 24, 1890. As it stands to-day the road is, according to the claims of its officials, the best in the world. It has about 6 miles of double track laid upon iron yokes placed 5 ft. apart, and weighing 500 lbs. each. The road is strong enough to carry the heaviest train that is run over the Pennsylvania Railroad. The cable cars weigh 15,000 lbs., each being 10,000 lbs. heavier than the horse cars. They run on two trucks of four wheels each.

Over 7,000,000 bricks were used in the construction of the power-houses. Each house contains two 500 H.P. Corliss engines, with groove wheels 26 ft. in diameter.

Thirty-two cotton ropes 2½ in. in diameter form the belt for the wheels.

The entire work was done by the United States Construction Company, of Philadelphia. Much of the machinery was made by the Robert Poole & Son Company, and Bartlett, Hayward & Company, of Baltimore.

The road runs the entire length of the city, from Druid Hill Park west to Patterson Park east.

PERSONALS.

WILLIAM A. HAMILL has been appointed Railroad Commissioner of Colorado.

S. C. WEISKOPF has been appointed Engineer and Eastern Agent of the Keystone Bridge Company, of Pittsburgh.

THOMAS COGSWELL has been appointed Railroad Commissioner of New Hampshire, in place of JOHN MITCHELL, resigned.

GEORGE M. BASFORD, late Assistant Engineer of Tests of

the Union Pacific, is now Signal Engineer of the Chicago, Milwaukee & St. Paul.

E. H. KEATING, late of Halifax, N. S., has been appointed City Engineer of Duluth, Minn. He has had much experience in wharf and dock construction.

THE new Railroad Commission of Texas consists of ex-Senator JOHN H. REAGAN, who needs no introduction; JUDGE W. P. McLEAN, a well-known lawyer, and L. L. FOSTER.

HON. JOHN H. B. LATROBE, for many years connected with the Baltimore & Ohio Railroad as a Civil Engineer, celebrated his 88th birthday at his residence in Baltimore, May 4.

C. H. QUEREAU has been appointed Engineer of Tests of the Chicago, Burlington & Quincy Railroad, succeeding F. W. SARGENT, who has resigned. Mr. Quereau has been Assistant Engineer for some time.

WALTER G. OAKMAN has been chosen Vice-President of the Central Railroad Company of New Jersey, succeeding JOSEPH S. HARRIS, who recently resigned in order to devote his time entirely to the business of the Lehigh Coal & Navigation Company. Mr. Oakman was recently connected with the Richmond & Danville Railroad.

SAMUEL M. ROWE has resigned his position as Chief Engineer of the Atlantic & Pacific, and is now engaged in building a narrow-gauge line running from Coolidge, N. M., southward. Mr. Rowe has been on the Atlantic & Pacific for some time, and had charge of the construction of the cantilever bridge over the Colorado at Red Rock.

REAR-ADMIRAL D. L. BRAINE, who has for some time past been in command of the New York Navy Yard, has been relieved from that position and placed upon the retired list, as he has reached the limit of age prescribed by law for active service. His successor in command of the New York Yard will be CAPTAIN HENRY ERBEN.

WILLIAM H. BURR, recently General Manager of the Phœnix Bridge Company, has severed his connection with that Company, and has purchased an interest in the business of Sooysmith & Company. From June 1 Mr. Burr is Vice-President of that Company, which is now as heretofore conducting the business of contracting and superintending engineers for bridges, substructures, foundations, docks, tunnels, and other works.

OBITUARY.

GEORGE R. CAMPBELL, President of the Campbell Frog & Crossing Works, died in Bucyrus, O., about May 1. Previous to engaging in the manufacturing business, Mr. Campbell was for a number of years Roadmaster of the Toledo & Ohio Central.

SAMUEL M. CUMMINGS, who died in Boston, May 6, aged 75 years, was for many years Master Mechanic of the Pittsburgh, Fort Wayne & Chicago Railroad, and was widely known as an active and efficient officer. He retired from active business several years ago, and had since lived in Boston.

FEW men can look back over 50 years of railroad service, but one of them was JOHN WALTON, who died recently in Elizabeth, N. J., aged 80 years. He entered the service of the old New Jersey Railroad in 1834, as a workman on the construction of the road between Elizabeth and New Brunswick. He remained on the road after it was finished, and about 1844 was made Section Master. He had charge of the section between Elizabeth and Rahway until he ended his 50th year of work in 1884, when the Pennsylvania Railroad Company retired him on a pension.

MAJOR PEYTON RANDOLPH, who died in Washington, April 22, was a civil engineer by profession, and his first work was on the location of the Richmond & Danville Railroad. He was also for a time on the Ohio & Mississippi. He served during the war in the Confederate Army, and after the close of the war was engaged on the Elizabeth, Lexington & Big Sandy road. In 1873 he was appointed Chief Engineer of the Virginia Midland and remained on that road nine years, for four of them being General Superintendent. In 1882 he was made Assistant General Manager of the Richmond & Danville, and in 1888 General Manager. Major Randolph was prominent and active in the transformation of the General Time Convention in the American Railway Association, and was one of the leaders in bringing about the change.

PETER WARD, who died in Newburg, N. Y., May 10, aged 63 years, was for many years a civil engineer and contractor. As a contractor he was well known, having laid hundreds of miles of road in various parts of the country, from the Atlantic to the Pacific coast. His last enterprise is not yet completed, that of the Zig-Zag Tunnel on the Ontario & Western Railroad. Mr. Ward was active in local affairs, and had served as Mayor of Newburg and in the New York State Senate.

LAWSON VALENTINE died May 5, at his residence in Mountainville, N. Y., aged 63 years. He was born in Cambridge, Mass., and in 1847 began his career in the paint and varnish business, in which he afterward became so well known, as an apprentice in Boston, with the firm of Wadsworth, Nye & Company. In 1852 he formed a partnership under the name of Stimson, Valentine & Company, for the purpose of manufacturing varnish, and this was the beginning of the large business which he afterward built up. The firm continued in business unchanged until 1867, when the style was changed to Valentine & Company. In 1882 this Company was incorporated, with Mr. Lawson Valentine for President. In the same year he retired from that office, however, and in 1886 started a new Company, the Lawson Valentine Company, of which he was President and active manager up to the time of his death. In his long business career he met with varied success, but succeeded fully in his general object, which was the establishment of the manufacture of varnish in this country, and it is chiefly due to his efforts that the imported varnishes were practically driven from the market.

Mr. Valentine during his whole business life was much interested in journalistic enterprises. He was the founder of the *Hub*, the oldest and best known of the carriage trade journals, and took an active interest in its conduct. In 1877 he became interested in the *Christian Union*, and was shortly afterward made President of that Company. He was also President of the Rural Publishing Company, which has issued the *Rural New Yorker* and the *American Garden*. He was a frequent contributor to his various publications, and also to the paper named *Varnish*, which he himself issued for the purpose of forwarding his business interests. In addition to this he was a silent partner in the publishing house of Houghton, Mifflin & Company, of Boston. Besides all of these business occupations he was an active member of the New York Chamber of Commerce, the American Geographical Society, and of a number of other societies and clubs. Mr. Valentine had many friends, and his death will be widely regretted.

PROFESSOR JULIUS ERASMUS HILGARD, formerly Superintendent of the United States Coast Survey, died in Washington, May 8, after a long illness. He was born in Zweibrücken, Bavaria, in 1825, and came with his parents to America 10 years later. His father was a lawyer, with strong tastes for literature and science, and he educated his sons so carefully that all became prominent in the scientific world. Julius was studying engineering at Philadelphia when, in his twentieth year, he attracted the attention of the late A. D. Bache, Superintendent of the United States Coast Survey. Professor Bache persuaded the young man to become his assistant, and for 40 years afterward Mr. Hilgard was in the Coast Survey Bureau, becoming the Superintendent in 1881, but resigning four years later. His relations with Professor Bache were those of a personal friend as well as assistant. The immense increase of work of the Bureau, occasioned by demands for information about our coast line by naval vessels and transports during the civil war, compelled Professor Bache to give up active work, his mind failing. Mr. Hilgard, who might have had the place, remained Assistant in charge of the office, and did his chief's work and his own, so that Mr. Bache might continue to draw his salary. In 1872 Professor Hilgard was a delegate to the International Metric Commission which met at Paris, and was offered the directorship of the International Bureau of Weights and Measures. In the same year he corrected the long accepted difference between the longitude of Paris and Greenwich. Later he superintended the magnetic survey of the United States provided for by a bequest of Professor Bache. He was one of the founders of the National Academy of Sciences, and was a member and once President of the American Association for the Advancement of Science, besides being a member of many other learned bodies. Most of his writings appeared in the publications of the Coast Survey Bureau, but he was known to many as a most lucid speaker on scientific subjects, which gen-

erally are discussed in terms above ordinary comprehension. Personally he was a man of high character, strong friendships, and extreme unselfishness.

Charles G. Ellis.

THE death of Charles G. Ellis, President of the Schenectady Locomotive Works, occurred at Schenectady on May 15. He took a slight cold while out driving two days before, which rapidly developed into pneumonia, which caused his death.

For the following particulars concerning the Schenectady Locomotive Works and Mr. Ellis's connection with them we are indebted to the *Daily Union* of Schenectady :

It was incorporated on June 14, 1851. The first buildings had been erected by citizens of Schenectady three years previous, under the name of the "Schenectady Locomotive Engine Manufactory." A company formed carried on the works one year, but unsuccessfully, when the buildings were closed and remained idle for a year, during which time a part of the personal property was sold for taxes. The whole works were finally sold at one half cost. The purchasers under the sale were John Ellis, Daniel D. Campbell, and Simon C. Groot. New capital was raised, and an organized firm resulted.

In the same year, 1851, Walter McQueen acquired an interest, which he still holds. In February, 1863, John C. Ellis bought out his original partners and obtained full control of the property. The war of the rebellion at that time made a lively demand upon the works for locomotives for government service in the hauling of trains of troops upon military roads at the seat of operations. In consequence the business grew to large dimensions, the force of operatives steadily increased, and the buildings became enlarged and increased. Mr. John Ellis died in 1865. His eldest son, John C. Ellis, then became President of the Locomotive Company. Hon. John C. Ellis died in 1884. Charles G. Ellis had become the President of the company the year before, with Walter McQueen, Vice-President, and Edward Ellis, Treasurer.

The works have been very much extended during late years, and now employ nearly two thousand men. Since the death of his father John Ellis, the son, Charles G. Ellis, as one of three brothers and a half-brother to whom the locomotive works' property descended, has been a very active factor in the management of the industry. He made an exhaustive study of the details of the business, and derived a full and practical acquaintance which ever after became of great assistance to him in his active efforts to advance the enterprise. He took a lively interest in the business, and gave daily attendance and often long hours to the work of managing details outside of the superintendent's duties.

Mr. Ellis served one term in the State Assembly in 1868. He was a constant attendant at the First Presbyterian Church, of which at the time of his death he was one of the trustees. He was also one of the directors of the National Mohawk Bank, and a very useful and serviceable one. Both church and State will thus feel his loss in a community point of view.

He was 48 years of age, and leaves a wife, one daughter, and many friends, not only in the community in which he lived, but wherever he was known.

PROCEEDINGS OF SOCIETIES.

Master Mechanics' and Master Car-Builders' Associations.—In view of some statements which have been made public lately, the following official announcement will be of interest :

"At a joint meeting of the Executive Committees of the Master Car Builders' and Master Mechanics' Associations held in the Murray Hill Hotel, New York, recently, a resolution was unanimously adopted, expressing confidence in the efforts Mr. Walton, Proprietor of the Stockton Hotel, Cape May, is making to accommodate the persons who intend to be present at the conventions. This was done after Mr. Walton had explained in detail his method of assigning rooms and his charges. The committees were satisfied that any person who does not call for a selected room can have room and board for $3 a day."

The proprietor of the Stockton Hotel announces that he will put up a special pavilion on the grounds of the hotel, in which space will be rented to exhibitors at the rate of 25 cents per square foot. Steam can also be supplied to run machinery.

The proprietor of Congress Hall, at Cape May, has issued the following circular : "This hotel will open June 6 for the Conventions of Car Builders and Master Mechanics. The hotel is brick, and will accommodate 500 persons. One thousand feet of piazza, for which there will be no charge for exhibitors. Terms, $3 per day for each person, not obliged to go two in a room. The hotel is two minutes' walk from the Stockton."

Northwest Railroad Club.—At the regular meeting, in St. Paul, May 12, Mr. C. A. Seley read a paper on Fuel and the Best Appliances for Lessening Consumption, in which he gave some interesting particulars of tests of locomotives made on the Great Northern Railroad. This paper was discussed by members present.

Seaboard Road Association.—This Association was formed at a meeting held in the rooms of the American Society of Civil Engineers in New York, April 28, representatives being present from several of the Eastern States. A number of addresses were made on the necessity of better roads, and it was resolved to organize the Association for the purpose of securing better roads and encouraging the formation of State associations to co-operate with the central society.

The officers chosen were : President, Colonel A. A. Pope, Boston ; Secretary, F. W. Skinner, New York ; Governing Committee, E. P. Carpenter, A. F. Noyes and A. A. Pope, of Massachusetts ; A. J. Coleman, of Rhode Island ; C. L. Burdett, of Connecticut ; J. Bogart, J. R. Dunn, and E. P. North, of New York ; F. A. Dunham and J. Owen, of New Jersey ; A. J. Cassatt, of Pennsylvania.

American Society of Mechanical Engineers.—The fifth monthly reunion of the Society was held April 30, in New York. The address of the evening was delivered by Park Benjamin, on the Story of the Beginning of the Science of Electricity. He traced the growth of the science from its first mention in literature, in 1490, to the present time. The lecture was illustrated with lantern slides. Nearly 150 members were present. After the lecture supper was served in the large dining-room.

American Society of Civil Engineers.—A regular meeting of the Society was held May 6, President Octave Chanute occupying the chair. After the transaction of routine business, the Secretary read a paper by Julien A. Hall, on Right of Way for Railroads, which was discussed by R. L. Harris, P. F. Brendlinger, C. J. Bates, E. P. North, C. B. Brush, J. F. Crowell, C. E. Emery, and others. The following candidates were announced elected :

Members : William Albert Allen, Portland, Me.; Edward Burr, Cascade Locks, Ore.; George Dowman Fitz Hugh, Birmingham, Ala.; Charles Webster Gay, Lynn, Mass.; Robert Giles, Topeka, Kan.; Howard Hill Jackman, Wichita, Kan ; Andrew Dempster Whitton, Philadelphia.

Associate Members : Frederik Christian Holberg Arentz, St. Louis, Mo.; William Ashburner Cattell, Long Island City, N. Y.; Harry Frease, Cleveland, O.; Thomas Henry Grant, Red Bank, N. J.; William Dean Janney, Ceredo, W. Va.; Richard Lamb, Norfolk, Va.; Frederick Morley, Ann Arbor, Mich.; Theodore Starrett, Chicago, Ill.; Edmund Coffin Stout, New York ; George Copeland Urquhart, Steubenville, O.; Sigmund von Gemmingen, Richmond, Va.; Edwin Hall Warner, Seattle, Wash.

The Secretary also announced the election of the following candidates by the Board of Direction :

Associate : Harry Comer.

Juniors : James Berrall, Edward Thomas McConnell, James C. McGuire, William C. Tucker, Frank Walker Wilson.

NOTICES are given that the annual Convention will be held at Lookout Mountain, Tenn., beginning May 21. On that day there will be morning and afternoon sessions, at which there will be short addresses having special reference to the topography and industries of that region.

On the second day, Friday, May 22, the business meeting will be held, and in the evening President Chanute will deliver his annual address. On Saturday, May 23, the day will be devoted to an excursion by steamer down the Tennessee River and return ; in the evening the annual banquet will be held.

On Monday, April 25, there will be two sessions, and probably an adjournment. After the Convention there will be opportunity for those members who desire it to accept the invitations which have been received to visit Nashville, Birmingham and other points.

A number of papers have been received, and are ready for distribution to those who attend the Convention.

Engineers' Club of Philadelphia.—At the regular meeting, April 18, it was ordered that the Directors be authorized to have the Club incorporated.

The tellers reported the following elections: *Active Members:* J. Clarence Ogden, John S. DeHart, Jr., Charles B. Colby, C. Louis E. Amet, Hermann S. Hering, Albert R. Cline, J. Adelbert Patton, William H. Boardman, and Fred C. Dunlap. *Associate Member:* David S. B. Chew.

Mr. Trautwine presented for Captain S. C. McCorkle an illustrated paper on Land-Locked Navigation from Long Island Sound to the Mississippi. The Author stated that he had simply given that portion of the route with which he is most familiar, leaving the distance from Long Island Sound to the St. John's and St. Mary's Rivers to others.

The portion of the route referred to between West Florida and Louisiana has for its initial point the Suwanee River. The exact point of departure depends upon the location of the Florida Ship Canal.

It is variously estimated that the distance from the Suwanee River to St. Mark's is from 70 to 90 miles, the former referring to a direct cut and the latter to a dredged line.

From St. Mark's to the Mississippi there is a water line nearly all the way, but requiring improvement.

The Oclockony and Crooked Rivers require straightening and the removal of sundry bars, which is not supposed to be difficult, and entirely practicable. In St. George's Sound, near Apalachicola, an oyster bar needs to be removed, and then the Apalachicola River is reached with 12 ft. of water on the bar.

The distance from St. Mark's, Fla., to Apalachicola, Fla., by the coast line, is about 61 miles—by the Oclockony and Crooked Rivers, about 10 miles longer.

From the Apalachicola River to the Mississippi the distance is about 400 miles, and it will require about 30 miles, possibly less, of canaling to make land-locked connection between the two rivers.

No attempt has been made to solve engineering difficulties or to make estimates—the route is given and the data furnished for some ambitious engineer to give to the country one of its most important means of coast defense, and to add to the commercial facilities of the whole country. Estimated total distance from the Suwanee to the Mississippi, 560 miles.

Estimated depth of water *en route*, 9 to 12 ft. at mean low water.

At the regular meeting, May 2, the Secretary presented, for Mr. George R. Ide, a paper descriptive of the Judson Pneumatic System for Street Railroads as constructed and operated at Washington, D. C. This system comprises connected, rotating cylinders lying below and between the rails of the track, and in line therewith, which cylinders are operated by compressed-air engines placed at intervals along the line. The cylinders are mounted in bearings in a conduit, and are engaged or clasped by a gripping mechanism suspended from the bottom of the car. The grip comprises two pairs of disks mounted so as to have their axes turned in an approximately horizontal plane to any desired angle with the axis of the underlying cylinder. When the axes of the disks are parallel with the cylinder axis the car will remain stationary, but when turned to any proper angle therewith the car will be moved. The velocity with which the car is moved depends upon the angle of inclination of the disk axes to the cylinder axis, the speed of the cylinder remaining constant. The speed of the car increases with the angle up to about 60°. With the cylinder in the same direction the car can be run forward, stopped or reversed by the mere change in the inclination of the disk axes, which inclination is under the control of the driver upon the car platform.

Civil Engineers' Club of Cleveland.—A regular meeting was held May 12, President Gobeille in the chair. Mr. John B. Weddell was elected corresponding member. A vote of thanks was extended to Mr. Aug. Mordecai for his donation to the Club of a crayon portrait of Mr. Charles Latimer, now deceased, former President of the Club. The Executive Board was instructed to incorporate the Club under the laws of Ohio.

The President appointed Mr. William T. Blunt as member of the Permanent Committee on International Engineering Congress and Engineering Headquarters in connection with Columbian Exposition of 1893.

Mr. James Ritchie read the paper of the evening, entitled Recent Advancement in Electric Engineering, describing some of the more remarkable discoveries, inventions, and improvements that have been made in this branch of engineering. This was followed by a discussion in which a number of members participated, and the new uses to which electricity has been put were described, as well as many other uses to which it may be put, but which are waiting for the necessary improvements of the electrical engineer before it can be done.

Engineers' Society of Western Pennsylvania.—At the regular meeting, in Pittsburgh, April 21, J. J. Thoresen, Samuel Foster, C. B. Connelly, and J. Atwood were elected members.

Mr. Daniel Stienmetz described the working of the Fales grate; Mr. John A. Brashear exhibited some samples of steel castings made by the Chester Steel Casting Company and by the Reliance Company of Pittsburgh.

Mr. Phineas Barnes then read a paper on Co-operation in Machine Design, which was discussed by members present.

Engineers' Club of Cincinnati.—The regular meeting was held April 16, with 28 members and several visitors present. Four applications for membership were received.

The following question received considerable attention from various members: "On reasonably firm sub-soil, which form of curb is to be preferred in street construction; 5 in. × 14 in. curb on 6 in. concrete with concrete backing to within 5 in. of the top, or 5 in. × 21 in. curb on clay or 2 in. gravel with earth backing, difference in cost being 10 per cent. in favor of the shallow curb?"

Mr. A. Petry read a paper giving a description of the apparatus used and the manner of measuring the quantity of water delivered to the reservoirs by the pumping engines forming a part of the new water-works plant being erected by the city of Covington.

Engineering Association of the South.—The regular monthly meeting was held in Nashville, Tenn., April 9. The death of Mr. H. S. Butler, of Anniston, was announced, and a committee was appointed to prepare a memorial. The memorial on the life of the late Mr. E. Pardon was submitted and approved. Mr. W. W. Perry, of Nashville, was elected a member.

Resolutions were adopted in relation to the meeting of the American Society at Lookout Mountain in May.

Major W. F. Foster, of Nashville, read a paper on the Engineering Profession, treating the subject under three heads: The relation of engineers to one another; their relation to their clients, and their relations to the general public. He advocated greater interest in the welfare and advancement of young engineers, and a spirit of mutual aid and good faith rather than of reserve and criticism. He also dwelt on the important office of engineers as arbitrators between their clients and contractors.

NOTES AND NEWS.

The Rose Polytechnic Institute.—This well-known school is one of those which is especially devoted to the education of civil and mechanical engineers. One of the peculiar features of the Institute is the thorough and extensive shop practice of the students in mechanical engineering. Not only are machines designed and working drawings made, but actual construction is required and is made possible in extensive workshops, the equipment of which has cost over $40,000. H. T. Eddy, the new President, is well known as the Dean of the Faculty of the University of Cincinnati, and a great educator and organizer.

Nicaragua Canal.—At the annual meeting of the Maritime Canal Company, of Nicaragua, in New York, May 7, Henry E. Howland was elected a Director in place of the late Frederick Billings. A. B. Darling, Charles C. Glover, of Washington, Franklin Fairbanks, C. Ridgely Goodwin, and Alexander T. Mason were chosen Directors for three years. All of them were re-elected except Mr. Glover, who succeeds Francis A. Stout, resigned.

The officers of the company chosen were: President, Hiram Hitchcock; Vice-President, Charles P. Daly; Secretary and Treasurer, Thomas B. Atkins; Chairman of the Executive Committee, James Roosevelt. The last-named gentleman succeeds Mr. Billings.

President Hitchcock's report showed that since December 1, 1890, much additional work had been done. The total length of breakwater built now exceeds 1,000 ft., and the channel dredged across the Greytown bar is over 150 ft. in width. The canal's right of way for purposes of immediate excavation has been marked out for 11 miles southwest of Greytown, with a width of 486 ft.

The work of excavating the artificial canal proper was actually

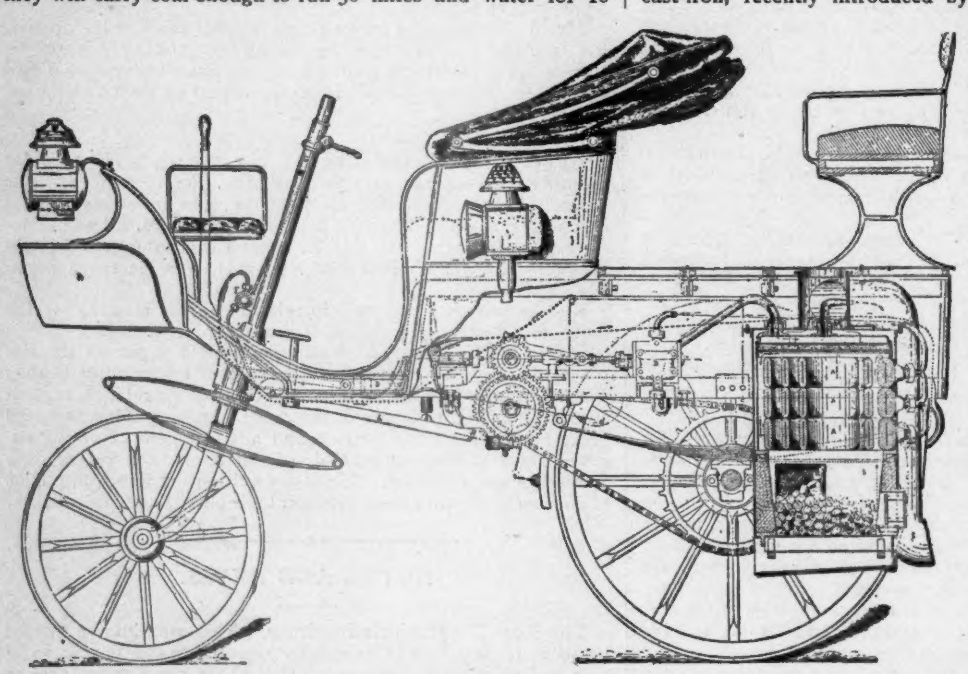
begun on January 1, 1891, and since then the dredgers have advanced about 1,300 ft. from the lagoon, making a channel 150 ft. wide and 20 ft. deep. This work is being done with dredges purchased last summer.

This is a distinct organization from the Construction Company, of which Hon. Warner Miller is President, but practically both companies are united.

A Steam Carriage.—The accompanying illustration, from the *Revue Industrielle*, shows a steam carriage invented and built in France by M. Serpollet, for use on common roads. It is a revival of an old idea, which has been attractive to many inventors. As will be seen, there is an upright tubular boiler and a small high-speed engine carried on the rear axle, the driving-shaft and the axle being connected by gearing and a chain. The front axle carries the steering gear. The smoke-stack is so arranged as to throw the smoke, etc., out at the back of the carriage. The cylinder of the engine is 5 in. in diameter and 5 in. stroke, and is arranged to cut off at 55 per cent. of the stroke.

In a recent trial trip of two hours the engine developed 5.3 H.P. indicated, making an average of 257 revolutions per minute. In that time the weight of water vaporized in the boiler was 267 lbs., with a consumption of 46 lbs. of coal.

The carriage shown has tanks and fuel boxes under the seat; they will carry coal enough to run 36 miles and water for 18



miles. Ready for work the carriage weighs 2,755 lbs.; it has carried seven passengers, has attained a speed of 12½ miles an hour, and has ascended a grade of 8 per cent. The longest run yet made has been from Paris to Douai, 143 miles, over a very good road, with sharp grades at several points.

Lighting the Harlem Tunnel.—The *Electrical Engineer* says: "The New York Central Railroad has begun experiments with a view to lighting the tunnel.

"The west-side rock-cut tunnel, through which its north-bound local trains run, has been lighted with incandescent electric lamps of about 40 c. p., placed alternately on either side of the track, about 125 ft. apart.

"Reflectors placed on the south side of the lamps prevent the glare of light from reaching the eyes of the engineer or fireman of approaching trains, and throw the light forward on the track.

"The lamps are placed 3½ ft. above the rails, and their light should not interfere in any way with the signal lamps, which are placed much higher.

"It has been alleged, and denied, that the New York Central officials have tampered with the arrangements so as to make it appear that the lighting did more harm than good by blinding the engineers. There is not the slightest reason why these small incandescent lights, properly placed, should have the effect of blurring or rendering useless signal lights."

Periodicals of the World.—The *Revue Scientifique* (Paris) estimates that 41,000 periodicals are now published in the world. Of these 24,000 are published in Europe, the leading countries as to number being Germany with 5,500; England and France, each 4,100; Austria-Hungary, 3,500; Italy, 1,400; Spain, 850; Russia, 800, and Switzerland, 450; the remaining 3,300 being divided among Sweden and Norway, Denmark, Portugal, Greece, the Balkan kingdoms, and Turkey.

The United States has 12,500; Canada, 700; Mexico and Central America, 600. The South American republics count up about 2,000 in all.

Japan claims 200 of the 300 periodicals credited to Asia. It seems, however, that this must be an under-estimate, for there are many more than 100 periodicals published in British India, though the number in other Asiatic countries is very small. Africa has 200 journals, the greater number appearing in the British colonies in South Africa, and in Algeria. Australia has 700, and there are a few published in the Pacific islands, Hawaii having 3 of them.

As to language, English has a decided lead, no less than 19,000 journals appearing in that language. German comes next with 7,500, and French third with 6,800. There are 1,800 in Spanish and 1,400 in Italian.

"Of making of many books there is no end." The Wise King would have some reason for his complaint had he lived to this day.

Toughening Cast-Iron.—The Manchester correspondent of the *Engineer* describes a very simple method of toughening cast-iron, recently introduced by Mr. A. Jepson, of Arcade Chambers, Manchester, and which was, in the first place, designed chiefly for the bottom and side plates of ordinary ovens; it has since been further developed for application to a variety of other purposes, and some brief notice of the invention will be of interest. The foundation of the patent is that with certain proportions of thickness of wrought iron to certain proportions of thickness to cast-iron a complete fusion or amalgamation of the metal takes place without altering the consistency of the wrought iron and without chilling the cast-iron, and the process is applicable to almost all cast-iron in which lightness and special strength are required. For instance, a piece of cast-iron ½ in. thick, with a core of 27 wire gauge wrought iron perforated sheet placed in the center, is increased in strength six times, and the plate is equal to cast-iron of fully an inch in thickness. Recently the process has been applied to the casting of large drain pipes to which great damage is frequently done in transit. By inserting a core of thin wrought iron into the castings of these pipes, they have been so strengthened that the liability to fracture in carriage has been reduced to a minimum. Another application of the process is for toughening the ash plates in front of boilers on board ship; these plates frequently getting nearly red hot, are consequently subject to fracture upon coming in contact with water; but by the adoption of Mr. Jepson's toughening process this danger has been entirely overcome. In the manufacture of oven plates it has been found that a thin sheet of wrought iron of 27 wire gauge put inside a ½ in. plate so toughens the iron as to render the plate practically unbreakable by fire. The process has also been applied to the manufacture of the bottom plate in hydraulic presses, where the severe strain frequently causes these plates to snap in two. The process of manufacture of such plates is to place two cores of 24 wire gauge sheets every 2 in. apart through a 6-in. plate, thus forming five layers, and the additional strength thus secured is sufficient to render the press bottom unbreakable. The thin sheets used for inserting in the castings are, it is added, very fine steel or wrought iron with a thin coating of tin; and as these can be blocked into any shape, they can be readily covered by the metal in almost every form of ordinary casting.

Submarine Cannon.—The *Turin Gazette* describes some experiments made in the Lake of Como with a submarine cannon, invented by a son of the engineer Toselli. The gun

was discharged at a depth of 100 meters, and the shell passed through an equal thickness of water in 10 seconds. The advantage consists in the gun being invisible to an enemy; and the object is, not to pierce an ironclad as a torpedo does, but to sink the hostile vessel, owing to the commotion produced by the explosion. A larger cannon is being constructed, under the inventor's direction, to be tested at Spezzia in the presence of naval and military authorities.

The Cost of British Drink.—The *English Mechanic* says: "It is appalling to find that the Drink Bill of 1890 amounts to £139,495,470—an increase of £7,282,194 over the sum of the previous year, all common sense and medical science notwithstanding. It is not our business, says the *Lancet*, to moralize on this expenditure. To us it means so much cirrhosis, Bright's disease, gout, rheumatism, insanity, etc., disabling employment, taking the pleasure out of the lives of families, and bread out of the mouths of children. The Drink Bill for last year is larger than for any year but that of 1878, when it was more than 142 millions of pounds."

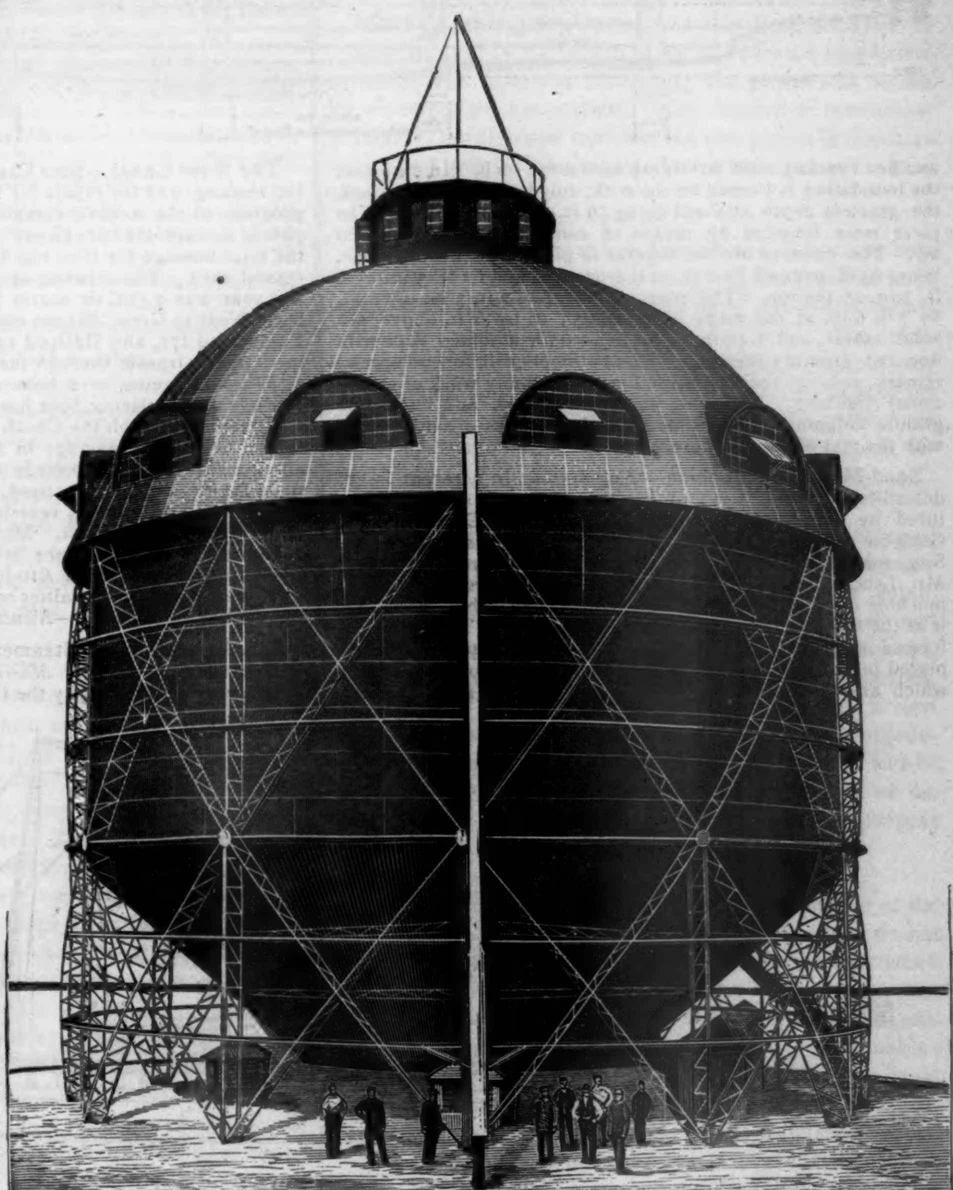
Rare Metals.—Some rare metals, possessing special qualities, are required for certain work. Thus palladium is used in making some parts of timepieces, and iridium for the points of gold pens, and the uninitiated have no idea of the value of such scarce products. Vanadium costs, for instance, 123,900 f. per kilogramme; zeconium, 79,295 f., and lithium, which is the lightest of metals, 77,090 f. per kilogramme. Rhodium, which is extremely hard and brittle, and is only fusible at a very high temperature, fetches 25,330 f.; and iridium, the heaviest substance hitherto discovered, costs 12,005 f. per kilogramme. It will therefore be seen that gold and silver are far from being the most precious metals as far as their market value is concerned. The cost of the most expensive metal, vanadium, is equal to $6,256 per pound; but the purchaser of a pound would probably "corner" the market.

Panama Canal.—It is stated in the *Engineer* that the latest scheme for the completion of the Panama Canal is the project of M. Amédée Sébillot, who proposes by means of a ship railroad to connect the two unfinished portions of the canal. The works would be completed in three years, and would cost $50,000,000. The locomotive is a novelty as regards design and construction. It is in the form of a ship's cradle, and the mechanism for propulsion is contained in the hollow interior. The cradle sinks under the vessel, draws it out of the water, makes the journey overland in two hours, and floats the ship in the other section of the canal without any further manœuvering. It is stated that the possibility of the scheme has been reported on by the Cail Company, who, in the event of the project being financed, would naturally have the contract for the iron and engineering work.

Fifty-three Hours for a Week's Work.—The Amalgamated Society of Engineers and other allied organizations have petitioned for a reduction of the hours of labor from 54 to 53 per week. They also ask for a uniform system of commencing and closing the week's work, namely, to start at 9 o'clock on Monday morning, work until 5.30 in the evening, and from 6 o'clock in the morning to 5.30 in the evening on Tuesday, Wednesday, Thursday, and Friday, and on Saturday from 6 o'clock in the morning until 12 o'clock at noon, thus completing the 53 hours.

[If these hours are compared with those which mechanics are commonly required to work in this country, it will be seen that they are not very much better off than the down-trodden workman of Great Britain, the McKinley Bill to the contrary notwithstanding.—EDITOR.]

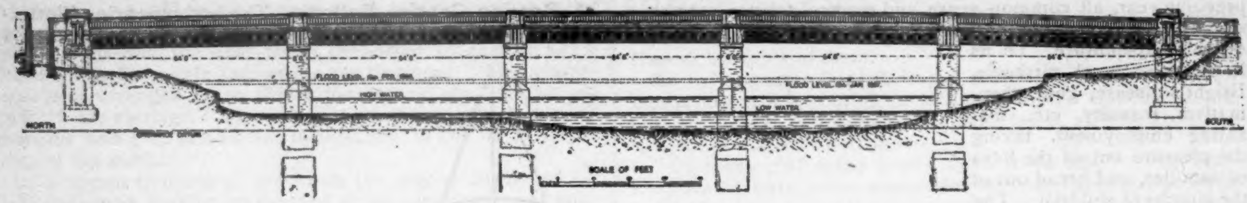
A Russian Captive Balloon.—The accompanying illustration, which has been sent us by a Russian correspondent, shows



an experimental "elevator" for purposes of observation, which has been built for the Russian Government at the Fortress of Warsaw, in Poland. The chief dimensions are: Height, 84 ft.; diameter of cylindrical portion, 70 ft.; diameter of lower tapering portion varying from 70 to 31½ ft. The capacity is 24,000 *chetwert*, and to fill it with gas requires 100 hours. The cost of the machine was 80,000 roubles or about $36,000. The iron work was made in St. Petersburg, and put together upon the ground. The machinery in the upper portion is driven by a gas-engine of 12 H.P., which also runs the dynamo for the electric lighting. This engine was built at Warsaw. The arrrangement is not very clearly explained, but apparently the intention is that the upper part should rise, being retained or held down to the earth by the framework surrounding the gas-holder.

The Dalmarnock Bridge.—The accompanying illustration, from *Industries*, shows the new Dalmarnock Bridge over the Clyde near Glasgow, recently completed. It consists of five spans, each 54 ft. 8 in. in length; the roadway is 32 ft. wide, and there are two sidewalks, each 9 ft. wide. The superstructure consists of five parallel web-girders, 3 ft. 6 in. deep, carrying a floor of steel buckle-plates, which are covered with concrete, on top of which are the pavement for the roadway and sidewalks. The parapet is of cast iron.

The substructure consists of two abutments and four piers. The bed of the Clyde at this point is composed of muddy clay and fine running sand overlying sandstone rock. In each case the foundation is formed on the rock, duly leveled and benched, the greatest depth attained being 56 ft. below river-bed. The piers were founded by means of caissons and compressed air. The caissons are rectangular in plan, with rounded ends, being 63 ft. over all by 9 ft. at the bottom, and 62 ft. 3 in. by 8 ft. 3 in. at the top. The piers, which are 62 ft. 3 in. over all, by 7 ft. 6 in. at cut-water level, and 53 ft. by 6 ft. above, are solid ashlar, and terminate in handsome moulded caps with fine red granite columns. The abutments call for no special remark, nor has their construction entailed any work of exceptional difficulty. The wing walls are curved, and handsome granite columns and moulded capping stones are in keeping with the rest of the structure.



Sand-Moulding Machine.—*Engineering*, in a recent issue, describes as follows Leeder's machine, which is now manufactured by the Patent Sand-Moulding Machine Company near Glasgow: "These moulding machines were first used in the Singer Manufacturing Company's Works, Kilbirnie, of which Mr. Leeder is manager, and proved a great success. The machine dispenses entirely with skilled labor, while the output is at the same time increased five or six times. The pattern is formed on the top and bottom sides of a parting plate, which is placed in position between the top and bottom moulding-boxes, which are then pressed together by hydraulic rams. These rams are fitted in a cylinder constructed in the baseplate of the machine, one ram fitting inside the other, and they can be worked either together or separately. The lower box is carried by the outer of these rams, while a plate fastened to the inner ram serves as a support for the sand with which it is filled, and this sand can be ejected as one mass from the box by admitting water to the ram. Both the upper and lower boxes are guided by two cylindrical rods connecting the baseplate of the machine with a top plate or entablature above, which serves as a support for the upper core box when the pressure is turned on below the rams. A second rod between the baseplate to the entablature carries the parting pattern plate, and allows it to be swung clear of the machine, when the moulds are to be removed. In working the machine the bottom mould is first filled with sand; the pattern plate is then swung into position, and the upper box lowered on it and filled. The pressure is then turned on beneath the rams, and the boxes are pressed up against the entablature, which thoroughly rams the sand. On removing the pressure the bottom box and pattern plate descend with the rams, the former to the bottom of the machine, but the pattern plate is arrested by a stop midway between the boxes, and can then be swung out of position. The upper box is then lowered down to the bottom one again, and the sand forced out of the boxes as one mass by the inner hydraulic ram. The system is specially valuable for repetition work, as one man and a boy can, it is said, turn out 1,000 boxes per day."

The Suez Canal.—Suez Canal statistics are always interesting reading, and the report for 1890 affords proof of the steady progress of the world's commerce. Last year 3,389 vessels passed through the Suez Canal; this is 36 fewer than in 1889, but the total tonnage for 1890 was 6,890,014, or 106,676 tons in excess of 1889. The number of British vessels using the Canal last year was 2,522, or nearly 75 per cent. of the whole number. Next to Great Britain comes Germany with 275 vessels; France had 171, and Holland 144. Progress has been made in the time of transit through the Canal, the average time being 24 hours 6 minutes, or 1 hour 44 minutes less than in 1889. The use of the electric light has increased the facilities for vessels passing through the Canal, the journey by night being accomplished on the average in 22 hours 9 minutes, which is 21 minutes less than the average for 1889. It is now four years since the electric light was used, and the progress has been very great. In 1887 only 395 vessels employed the light, while last year 2,836 vessels used it. Most of the vessels obtain the apparatus from agents at Suez or Port Said, the light being supplied at a uniform rate of £10 for the transit. It is also to be noted that very few casualties took place during the year, and none of any importance.—*Nautical Magazine.*

A Lake Passenger Steamer.—The accompanying illustration, from the Cleveland *Marine Review*, shows the steamer *Virginia*, recently built by the Globe Iron Works at Cleveland for the Goodrich Transportation Company, to be used as a passenger boat on the line between Chicago, Racine and Milwaukee. The boat is fitted up in very handsome style, has accommodations for a large number of passengers, and is lighted throughout with electric lights.

The *Virginia* is 278 ft. long over all, 260 ft. keel, 38 ft. beam, and 25 ft. deep. She is propelled by twin-screws; each screw is driven by an inverted, direct-acting triple-expansion engine, with cylinders 20 in., 32 in., and 52 in. in diameter and 36 in. stroke. Steam is furnished by two double-ended boilers 13 ft. in diameter and 21 ft. 2 in. long, having 12 furnaces. The working pressure will be 160 lbs., and at 130 revolutions per minute the engines are expected to give the boat a speed of 18 miles an hour. There are eight auxiliary engines for the pumps, dynamos and steering gear.